State policy, liberalisation and the development of the Indian software industry

Thesis

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Submitted for the degree of Doctor of Philosophy

Technology Policy Group
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Abstract

This thesis investigates the relationship between industrial development and industrial policy in a developing country. The chosen industry - software - is of recent origin and of growing importance in many developing countries, for which it can present one of the best entry points into the information technology production complex. Yet this industry and, particularly, the role of state policy in its development have been relatively neglected within the literature.

The key policy issue of recent years has been policy liberalisation, and the thesis takes as its central theme the role that policy liberalisation plays in software industry development. A specific case study is made of the Indian software industry and Indian software policy because these have been long-standing, and because they combine high growth with liberalisation.

The conclusion reached is that certain policy liberalisations may have a role to play in software industry development but that liberalisation cannot be seen as a 'panacea' for such development. The impacts of some liberalisations run counter to some long-term development objectives while state intervention is seen to have played a positive and necessary role in assisting software industry growth. At the same time, certain liberalisations are found to be either politically or financially unfeasible.

Software policy makers face a major decision on whether to orient their industry towards the domestic or export markets. It is argued that the Indian industry has shown an export bias which should be reduced by greater orientation to the domestic market. Other developing countries may need to focus even more on domestic-oriented production rather than exports.

Policy is not the only determinant of software industry development because technology, market entry barriers, input supply constraints, and producer-consumer relations also play a part. Nevertheless, policy has a very important role to play and should be applied in a non-dogmatic way that is responsive to the specific and changing circumstances of individual nations and industries.

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Publications

Material contained within this thesis has been included in the following publications.

'Soft option is hard work for India', The Independent, Computing section, p16, 31/7/89

New Technology and the International Division of Labour: a Case Study of the Indian Software Industry, DPP Working Paper no.17, Open University, Milton Keynes, 1989

'Fourth generation languages (4GLs) and the Indian software industry' in Information Technology in Developing Countries, S.C. Bhatnagar & N. Bjorn-Andersen (eds), North-Holland, Amsterdam, 1990, 251-63

'Dangers in the fourth generation', Asian Computer Monthly, April 1990, p16

Software Policy in India: Desired and Desirable Changes, Centre for Technology Strategy, Open University, 1990

'4GLs: dream or nightmare?', Dataquest, May 1990, 114-16

'Government policy - bane or boon?', Asian Computer Monthly, July 1990, p19

'Technology policy making as a social and political process: liberalizing India's software policy', Technology Analysis & Strategic Management, 2(3), 1990, 275-91

'The government's policy - bane or boon?', Dataquest, October 1990, p84

Contents

Chapter 3 : Measuring Industrial Development

Chapter 7 : Foreign Collaborations

Chapter 8 : Government Interventions

Chapter 9 : Making and Changing Policy

Chapter 10 : Overall Summary and Conclusions

Appendix A : Additional Data

List of tables

List of figures

CHAPTER 1

INTRODUCTION AND OVERVIEW

Introduction

The study presented in this thesis focuses on the relationship between industrial policy and industrial development in the Third World. Specifically, it looks at the impact of the key policy issue of the 1980s - liberalisation - on one of the key industries of the 1980s - software. It chooses the case of Indian software policy and the Indian software industry because these have presented a long-standing combination of liberalisation and high growth.

The chapter that follows draws out the reasons for these various choices, based on a survey of relevant literature, and builds towards the central question of the thesis:

How has the development of the Indian software industry been affected by liberalisation of state policy?

It also outlines the method of data gathering used and summarises the arguments and structure of the thesis.

1. Choice of industrial policy issue

This section, based on a survey of the literature, explains how liberalisation has come to be one of the most important policy issues at the time of writing.

The world of policy and policy making for developing countries has always been inhabited by a number of possible models which policy makers are exhorted to follow. Overlain on this has been a dynamic such that, at any given time, one of these models will be held up as a paradigm, as the model to follow, in order to attain developmental goals. Writers such as Stecher (1981), Kaplinsky (1984b), Weiss (1988), and Colclough (1989) chart the changes that have taken place in the paradigmatic model.

While most developing countries were under colonial rule, a Non-Industrial model was broadly accepted:

> "Until the early 1930s there was little disagreement among economists or policy-makers that the system of international division of labour then prevailing - industrial countries producing manufactures and developing countries supplying primary commodities - was more or less equally beneficial for both groups." (Stecher 1981)

In the post-war, independence period, after a decade or two of deterioration in the terms of primary commodity trade, a structuralist, pro-industrial model developed, which emphasised the benefits of developing country industrialisation:

> "Industrialization seemed the appropriate course because it not only promised self-sufficiency for nations that had just regained political sovereignty, but it also offered external economies accruing from technical progress" (Stecher 1981)

Structuralist ideas varied, but it was generally seen that industrialisation would be achieved by government intervention, by protection from imports, and by a process of import substitution (Stecher 1981, Weiss 1988:116). Such views were partly reinforced by the work of the dependency school of writers, such as Frank (1967) and Amin (1976) (who constituted one element of structuralist thinking), which emphasised the structural constraints within links between developing and developed countries and, hence, the limitations of industrialisation involving foreign capital.

Although a somewhat diverse body of theories, structuralism remained 'the dominant intellectual paradigm in the economics of developing countries over the years 1950-1980' (Colclough 1989:2) but, in the 1970s and, to a greater extent, the 1980s, a neo-liberal model came into the ascendancy which emphasised the importance of price and market mechanisms, and the deficiencies of government intervention and import substitution (Kaplinsky 1984b, Weiss 1988:171).

Not surprisingly, there has been much academic debate about the validity of both the structuralist and the neo-liberal models, and about the impact of related policy prescriptions. This is therefore the policy issue to which the thesis addresses itself.

Liberalism and neo-liberalism

The origins of liberalism can be traced to the writings of John Locke in the seventeenth century, 'defending the rights of the individual against the commands of monarchs and other rulers' (Moss 1982; see also Dahrendorf 1987). The ideas of classical economic liberalism were developed particularly by Adam Smith in the eighteenth century, with his concept of the 'invisible hand' of the market which would ensure the greatest welfare for all. It is 'the philosophy which advocates the largest possible use of the forces of competition as a means of co-ordinating human efforts and achieving economic ends, and thus rejects most types of coercion and interference in economic life by interest groups or governments' (Seldon & Pennance 1976).

Neo-liberalism is a more recent resurgence of the same ideas, which became recognisable from the 1960s in the work of economists such as Freidrich A. Hayek and Milton Friedman. 'In one sense, this was, and is a return to the original project of asserting society against the state, the market against planning and regulation, the right of the individual against overpowering authorities and collectivities' (Dahrendorf 1987). Key writers in relation to developing countries include Balassa (e.g. 1971), Bhagwati (e.g. 1978), Krueger (e.g. 1978), and Little, Scitovsky and Scott (1970). The work of these writers tends to take a more relative position than that of their earlier counterparts - they admit that there are neither ideal markets nor ideal states, but argue that 'imperfect markets are better than imperfect states' (Colclough 1989:5).

1.1. The change from structuralism to neo-liberalism

One can interpret the change in prominence from a structuralist to a neo-liberal paradigmatic model in terms of a Kuhnian paradigm shift (Kuhn 1962). This would explain that a new paradigm gradually emerged because of mounting evidence on inconsistencies and problems with the old paradigm.

As a crude generalisation, the 1970s can be characterised as a decade of evaluation of the outcomes observed from countries which were being guided by structuralist policy prescriptions. Neo-liberal writers of the time criticised the application of the structuralist model as having led to technological backwardness and declining growth rates in developing countries. They argued, too, that government intervention reduced efficiency and acted as a systematic bias against exports (Weiss 1988:171).

At the same time, these writers were able to offer alternative prescriptions, based on the neo-liberal model which, it was claimed, presented a solution to the problems of growth, efficiency and technical progress (Chishti 1985, Cline 1987:10-11, Foley 1989:6-8).

Much of the neo-liberal evidence was instantiated by claims of a 'real-world' example of the success of the neo-liberal model (Kaplinsky 1984b). This took the form of the so-called Newly Industrialised Countries (NICs)[1] - South Korea, Taiwan, Singapore and Hong Kong - whose economies had shown dramatic and sustained growth over a number of years thanks, it has been claimed (for example, by Little 1981 and Keesing 1988), to their following neo-liberal policy prescriptions.

A strong association was made between successful development, the NICs, and the neo-liberal model, and this had dramatic effects.

> "The consequence has been a major reorientating of strategies, both by individual countries and by multilateral agencies." (Kaplinsky 1984b)

Neo-liberal policy prescriptions have guided or influenced policy making in many developing countries (including India, China, Brazil, Mexico, Argentina, and Chile) during certain periods in the 1970s and, particularly, the 1980s, with such prescriptions marking a changeover from earlier, more structuralist influences. Such a changeover has been strongly supported by agencies such as the World Bank and the International Monetary Fund which have been repositories of much neo-liberal thought, and which have often made the introduction of neo-liberal policy prescriptions a pre-condition for receipt of funding.

Following this, and particularly towards the end of the 1980s, there were attempts to analyse the impact of neo-liberal policy prescriptions. This analysis was seen as the critical area of academic debate at the time of writing, helping to determine future policy directions for developing countries.

It was therefore decided to focus this thesis on the practical results observed when a specific developing country began being guided by neo-liberal policy prescriptions. Drawing out the costs and benefits of following neo-liberal policy prescriptions was seen as the key industrial policy issue to be addressed within the present study. As discussed below, this issue was placed into the context of a relatively new but important industrial sector - software.

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[1] A glossary of acronyms is presented in Appendix A.

2. Liberalisation - the key neo-liberal policy prescription

This section analyses the policy prescriptions for industry recommended by the neo-liberal model, in order to set the framework for the case study and policy discussion which follow.

The structuralist and neo-liberal models are sometimes presented in an 'either ... or' context. However, they are better represented as extremes on a continuum:

Structuralist —————————————————————————— Neo-liberal

Neither of the extreme positions (i.e. ideal state or ideal market) exist in reality (Guha 1990a:3) and most national policies can be described as lying somewhere along the intervening continuum (Sheahan 1986). Policy prescriptions derived from either model do not advocate the adoption of one or other extreme, but a move along the continuum in the direction of the appropriate model.

Liberalisation is the central policy prescription deriving from the neo-liberal model. Liberalisation is therefore a process; a process of change along the policy continuum away from the structuralist extreme towards (but not reaching) the neo-liberal extreme:

Liberalisation
-->
Structuralist —————————————————————————— Neo-liberal
T_1 T_2 P_1

Seen in this way, it can be understood that it is quite possible to support certain types of liberalisation (such as a move from T_1 to T_2) whilst still believing that the neo-liberal model is incorrect. It can also be seen that someone arguing for a compromise position (such as P_1) might advise either more <u>or</u> less liberalisation depending where on the continuum a nation's policy was already judged to lie.

2.1. Liberalisation in the context of industrial policy

Liberalisation can be applied as a process of change to many different policy areas. A number of authors (including Cline 1987, Colclough 1989, Foley 1989, and Kydd & Spooner 1990) have chosen different ways to categorise these various policy areas and changes. The most useful for the purposes of this study was seen to be that used by Weiss (1988:26-27). He highlights four main areas in which industrial policy change can be applied:

i. Trade
ii. Government control of industry
iii. Foreign investment
iv. Ownership by public or private capital

There are other policy areas outside the field of industrial policy in which liberalisation may take place, but only these are of direct relevance to the present study. Fransman (1986:96-101) draws out a similar pattern, but adds an additional element - the prioritising of certain industrial sectors over others.

Within each of the four areas specified, a policy continuum may be identified which will indicate the direction and type of change that liberalisation would involve.

I. Inward-looking ... Outward-looking

This continuum is often treated as being equivalent to:

Import substitution ... Export orientation

Understanding and use of these terms has been clouded (Berberoglu 1987) in theoretical terms because many writers use import-substituting industrialisation (ISI) and export-oriented industrialisation (EOI) as synonyms or near-synonyms for the structuralist and neo-liberal approaches respectively, while others treat the two continua as quite different. There has also been confusion in practical terms when trying to classify countries because one can classify in terms of trade or production or policy; because policies change; and because import-protecting and export-encouraging policies can exist simultaneously (Weiss 1988:41). The definitions to be used here draw on the work of McAleese (1975), World Bank (1987), Weiss (1988:28), and Foley (1989:4), and they treat inward-looking policy as a sub-set of the structuralist model and outward-looking policy as a sub-set of the neo-liberal model.

According to most versions of the neo-liberal model, free trade is advocated because it would allow export trade to fall into line with the international division of labour and with local comparative advantage (Stecher 1981, Foley 1989:26-27), that advantage being primarily determined (according to Heckscher and Ohlin) by the relative abundance of factors of production within the country (Cline 1987:8-10). Although the more sophisticated versions of the outward-looking approach (such as some of Balassa's work) provide something of an exception, it would be generally true to say that outward-looking views have focused more on static comparative advantage (and other indicators), while inward-looking views have focused more on the dynamics of comparative advantage (and other indicators) (Schmitz 1984, Weiss 1988:175-77, Gaio 1989:150).

In the structuralist model, domestic production would receive some subsidy or protection as compared to imports, to ensure the build-up of skills and competitiveness and of long term growth. In the neo-liberal model, free trade would be the goal which, it is argued, would allow economies of scale, greater efficiency (including the X-efficiency gains of technical progress), and rapid industrialisation (Little 1981, Cline 1989:10-11, Foley 1989:6-8). The adoption of extreme positions on this is now rare and it is the general view that some initial protection is acceptable but also that extensive protection should not go on forever. However, there is still a basic difference in attitudes with structuralists favouring trade protection and neo-liberals favouring free trade.

It is also argued that, in the structuralist model, domestic market sales are the primary focus and receive higher aggregate incentives than export sales, whereas under neo-liberalism there is neutrality such that aggregate incentives are equal (McAleese 1975, World Bank 1987).

Liberalisation would aim to move policy away from being inward-looking towards being outward-looking. Trade liberalisation would therefore typically involve the use of export subsidies to offset protection and to reduce anti-export bias; exchange rate devaluation; removal of import quotas; and reduction of import tariffs.

The issue of export subsidies is covered in chapter 4, while the question of import policy is discussed in more detail in chapters 5 and 6 of the thesis.

Super export orientation

The neo-liberal model of export orientation requires aggregate incentive neutrality between export and domestic sales. However, some nations - notably South Korea and Taiwan - have gone beyond this and used policy instruments to ensure that export sales receive a higher incentive than domestic sales (Fransman 1986:79, Cline 1987:134). This bias towards exports may be called 'export specialisation' or 'super export orientation'.

While such an approach has been seen to benefit from economies of scale, and to create an expansion in both production and employment, it can suffer from a number of drawbacks:

i. Import-intensity of exports to the extent of minimal or even negative trade surplus (Cline 1987:134), and a failure to 'catch-up' technologically.
ii. Uncertain survival thanks to reliance on an unstable world market in which political events or increased protectionism in the developed countries can harm trade (Kaplinsky 1984b, Schmitz 1984, Ghosh 1987, Guha 1990b).
iii. The fallacy of composition. While it may initially be possible for some developing countries to follow an export path, it is inconceivable that all of them could do so without a huge growth in global demand and/or a drastic change in world trade patterns (Kaplinsky 1984b, Weiss 1988:58).
iv. New technology may arrive which undermines the comparative advantage of developing countries (Rada 1980a, Rada 1980b, Kaplinsky 1984b).
v. Lack of linkages to the rest of the economy and 'little transfer of know-how and skills' (Schmitz 1984).

It will be argued in chapter 4 that the case study presented here is an example of 'super export orientation'.

ii. State ... Market

This is, perhaps, the central element in the models presented above. While the structuralist model argues that state intervention is necessary in order to overcome inherent market entry barriers, constraints and imperfections, the neo-liberal model argues that market forces can guide decision making more efficiently than the state and that:

> "All direct state actions to promote industrialisation (protection, licensing, reserved markets, subsidies to labour or other inputs ..., state-led research and development) diverts [*sic*] resources away from more immediately profitable uses." (Colclough 1989:9)

Although some authors (e.g. Kydd and Spooner 1990) think otherwise, it is generally seen within neo-liberal writings that the state should withdraw from intervention in the supply of inputs, the production process itself, and demand for final products,:

> "Variables with enormous influence upon long-run outcomes - technology, labour supply and quality, capital stock, natural resources and their replacement - are relegated, in these recent writings, to a category which will look after itself." (Colclough 1989:4)

Liberalisation would aim to move policy away from state intervention towards greater control by the market. Liberalisation of industrial controls would therefore typically involve a reduction in the state's role in provision of finance, training and infrastructure; a reduction in controls over industrial entry and production capacity; a reduction in legal requirements governing industry; a reduction in tariffs and price controls; and removal of any favouritism towards local products in purchasing decisions.

Of course, all such changes need to be well planned and implemented, and it is one of the ironies of the neo-liberal model that, while in theory it advocates a 'rolling back' of the state, in practice it requires a good deal of government activity and control (Mody 1983, Ghosh 1987). As will be seen later, it can also be argued that the neo-liberal model takes too narrow a perspective by focusing solely on the economic dimension of policy and the economic role of the state.

While chapter 4 discusses the liberalisation of certain state controls, chapter 8 looks at the importance of government intervention in industrial development.

III. Anti-foreign Investment ... Pro-foreign Investment

The structuralist model (at least in its dependency form) argues that penetration of the local economy by foreign capital creates local trade and production patterns geared to the needs of elite groups in developed countries, and not to the needs of the mass of the local populus. The costs of this include overly capital-intensive production, specialisation in primary product exports and unequal trade exchange (Weiss 1988:42). Such foreign investment, it is argued, should therefore be avoided or at least tightly regulated by the state. By contrast, the neo-liberal model argues that foreign companies provide much needed inputs of capital, skills and technology and it therefore welcomes foreign investment.

Liberalisation would aim to move policy away from a negative towards a more positive view of foreign investment. Liberalisation of foreign investment would therefore typically involve an encouragement of foreign investment and a reduction of controls, such as limits to foreign share ownership and repatriation of profits.

These elements are discussed in more detail in chapter 7 of the thesis.

iv. Public ownership ... Private ownership

The structuralist model argues that private capital will not be attracted to certain industrial sectors which are important for the long-term growth of the economy, and that non-profit development objectives will not be achieved by private industry. The neo-liberal model argues that private ownership is the best guarantor of efficiency and growth.

Liberalisation would aim to move policy away from public ownership and investment towards more private ownership and investment. Liberalisation of ownership would therefore typically involve privatisation of publicly-owned industries, more contracting out of public services, and a reduction in state investment.

As regards the chosen case study, by far the majority of the Indian software (and hardware) industry lies in the private sector, and there have been no plans to alter this. Therefore, while the question of ownership arises in some chapters, it is not an issue that figures prominently in this thesis.

Industrial sector specificity

In general, the neo-liberal model recommends that governments should not develop sector-specific industrial policies (Fransman 1986:77, Foley 1989:11-12). Some neo-liberal writers (Balassa 1982:68, World Bank 1987) allow that while, in theory, sector specificity might be the correct course of action, in practice, it would be better to let market forces rather than governments decide where industrial priorities lie. Liberalisation of sectoral policies would therefore typically involve a reduction in sectoral specificity and in variation of policy between sectors (Weiss 1988:264).

2.2 Evaluating liberalisation

The foregoing discussion has highlighted the outcomes that will be of interest in evaluating liberalisation. These include quantitative measures such as industrial growth, efficiency and balance of payments as well as others that include technical progress, build-up of local skills and technological capability, dynamic patterns of international division of labour and comparative advantage, degree of dependence on transnational corporations, and industrial growth constraints. Export stability, influence of new technology, and links to the domestic economy will also need to be considered in relation to exports. Finally, it will be important to know which features are specific to this case study and which may be more generalisable.

During the 1980s, many neo-liberal writers continued to publish in support of neo-liberalism, but other academic debate can be crudely characterised in two ways. Firstly, a number of writers (including Nayyar 1988, Singh & Ghosh 1988, Weiss 1988 and Das Gupta 1990) began evaluating liberalisation in terms of the outcomes just listed. Secondly, there was a re-analysis of the experience of the NICs by many writers (including Datta-Chauduri 1981, Bienefeld 1982a, Bienefeld 1982b, Luedde-Neurath 1983, Evans & Alizadeh 1984, Schmitz 1984, Mody 1985, Fransman 1986, Cline 1987, Weiss 1988, Evans & Tigre 1989 and Guha 1990b).

These writers have argued against the neo-liberal interpretation and against the omnipotence of liberalisation in three main ways.

Firstly, it is argued by many of those listed above that industrial growth in the NICs (except, perhaps, Hong Kong) and other developing countries has been built not on a neo-liberal model, but on import substitution and pervasive state intervention as regards purchasing policies and controls on imports, labour, and both local and foreign capital. While it is true that there were liberalisations in the NICs in the 1970s and 1980s, to identify these policy changes as the cause of growth would be to misunderstand the historical process of development.

Linked to this, writers from the first group mentioned above have produced evidence that liberalisations have failed to produce the promised economic developments. Both groups of writers therefore argue that perceived problems with structuralist prescriptions do not logically and necessarily imply the need for neo-liberal prescriptions and that industrial development cannot be 'left to the market' as suggested by the neo-liberal model.

Secondly, it is said by these writers that one cannot extrapolate from the NICs' experience because their growth depended on a specific set of geo-political and historical advantages and opportunities, and a specific set of state and industrial structures. Crucial determinants in South Korea's growth, for example, are seen as the homogeneous nature of the state, the close links between public and private sector, proximity to booming Pacific rim markets, and the destruction of previous organisational forms by the war (Evans & Alizadeh 1984, Mahalingam 1989).

Thirdly, and linked to the previous point, there are many factors other than policy which must be taken into account when seeking to understand economic development. These include the technology involved (Fransman 1986, Lall 1987, Gaio 1989), the external macroeconomic environment (Nayyar 1988, Guha 1990b:48-49), and the structure of industry (Bagchi 1982, Kabra et al 1987, Bagchi 1990, Guha 1990a).

Many of these writers therefore argue that one cannot base policy prescriptions on relatively extreme and deterministic theoretical positions, and they support neither the neo-liberal nor the structuralist model. In reality, they say, policy making will require a mixture of import substitution and export orientation, and a mixture of liberalisation and intervention, with policy measures being matched to individual circumstances (Schmitz 1984, Hussain 1987, Reddy 1987:222, Weiss 1988, Nayyar 1988, Foley 1989, Bagchi 1990).

Summary

In the 1980s, the neo-liberal model took over from the structuralist model as the dominant economic policy model. The practical application of this changeover - policy liberalisation - has been seen within many developing countries in which industrial policy liberalisation has taken place along a number of different axes including trade, government control, investment, ownership, and sectoral specificity. The issue of the outcomes of liberalising industrial policy has been the central point of recent industrial policy debate, and therefore forms the key policy issue within this thesis.

A number of writers have addressed this issue in the context of various nations or industries during the 1980s. Some have concluded their evidence and arguments in favour of neo-liberalism, while others have pointed to several significant shortcomings and to the need for a different approach. However, no attempt has been made to address this issue to an industry of increasing importance to developing countries - software - which is discussed more fully in the next section.

3. Choice of industry

If this case study wishes to add to existing knowledge, it would be best focused on a neglected, but important, industry. The software industry fulfills both these criteria.

Information technology (IT) is diffusing rapidly into all industrial and service sectors and is now seen as one of the most crucial technologies affecting economic growth in developing countries (Rada 1980b, Narasimhan 1984:2, Kaplinsky 1987). Developing countries which fail to introduce new information technologies will be left with an increasingly inefficient system of administration and with obsolete, uncompetitive production methods (Perez 1985, Schware 1990a).

Within the overall set of technologies that make up IT, software is vital since other technologies cannot function without it (UNIDO Secretariat 1983:5-6, Correa 1985:1). Software has also been forming an increasing component of overall value within information technologies (Boehm 1973, Gaio 1989:98) and 'is increasingly becoming a pervasive technology embodied in a vast and highly diversified range of products and services' (Gaio 1989:316).

The development of a local software industry can therefore lead to many positive externalities (Kopetz 1984:12-13, Fialkowski 1990), and is seen as a necessity in order for developing countries to be able to adapt software technology to suit their particular local needs (Narasimhan 1984:8, O'Connor 1985, Schware 1987).

> "Software production is nowadays an industry, essential for the growth of the economies of the developing countries; and the launching of programmes to promote strong and indigenous software industries is a priority task." (Fialkowski 1990).

Software production is also seen as the best entry point for developing countries into the IT production complex (UNIDO Secretariat 1983:9, O'Connor 1985, Schware 1987, Fialkowski 1990). For example, compared to hardware production, software production is less capital-intensive, more labour-intensive, has a lower rate of obsolescence, and (at least in certain areas) has far fewer economies of scale (O'Connor 1985). All of these factors favour developing countries, and software's labour-intensity of production offers a clear opportunity for them compared to many other production processes.

Hence, it is not surprising that 'in developing countries interest in both the production and the use of software is becoming more intense' (Schware 1990a; see also UNIDO Secretariat 1983:1), and that actual production is also increasing. India, China, Brazil, Mexico, Singapore, Hong Kong, Taiwan, South Korea, Sri Lanka and the Philippines all have software industries worthy of note, with growth rates of 30% and 40% being not uncommon (Schware 1989:32-36).

Software production is also of interest not just because it is a relatively recent phenomenon, but also because it has certain specific features, described in more detail in later chapters. The technology especially is unusual because it is pervasive and functionally complex yet also intangible, modifiable after initial production to create a new product, and with a lack of any clear distinction between production tools and the final product. The production process is also highly skill-intensive, while certain types of production rely on labour mobility and on a rapidly growing world market.

All of this makes software unlike any other technology, and the software industry unlike any other industry (see also Kanodia 1990b). This suggests that policy prescriptions which hold good for other industries may not apply in this case, and that a specific study of software is required.

There is a clear need for governments to create a software-related policy (UNIDO Secretariat 1983:21,28, Kopetz 1984:13, Narasimhan 1984:80, Schware 1987, Fialkowski 1990), and both those countries which have set up software industries and those which are interested in doing so are seeking the optimum set of policy measures to ensure the most successful development of their software industries.

Yet, policy advice for developing countries about software industry development has been surprisingly rare and limited, and advice based on detailed study of such industries has been virtually non-existent. While the work of the authors listed here has included recommendations for certain interventions, most advice has tended to address a few specific issues in a detailed and technocratic manner rather than looking at overall policy strategies for development.

Only Schware (1987) has offered wide-ranging guidelines on software policy but even these are not set within an overall industrial policy framework, and none of the work shows any real understanding of the major policy objectives to be determined. Perhaps partly as a result, software policies have been relatively neglected and comparatively rare in developing countries (Correa 1985:1).

It was therefore felt that this important, but neglected area, linking the major current issues in industrial policy to one of the key high-technology industries, should be addressed within this thesis, in order to provide a greater understanding of desirable software policy strategies for developing countries.

As well as being a new area for study, software production in developing countries also provides a useful testing ground for ideas on policy liberalisation because production has been aimed at both export and domestic markets, contains elements of state intervention as well as market-driven decisions, and involves both foreign and local, public and private capital. It additionally offers a ready guideline for assessing qualitative progress under particular policy regimes because it presents a relatively easy entry point into either export or domestic markets through programmer services, but also covers a range of activities up to much more design-, skill-, technology- and marketing-intensive operations.

3.1. Software, hardware and software production

Before proceeding, some basic definitions relating to software need to be given.

The technologies involved in computing are normally divided into *hardware* and *software*. *Hardware* is 'The mechanical, magnetic, electronic and electrical devices which make up a computer', while *software* is 'The instructions, programs, or suite of programs which are used to direct the operations of a computer, or other hardware' plus associated documentation (Meadows et al 1987:114,226; see also Kopetz 1984:4). Software consists of a series of instructions, which are often grouped together as subroutines or modules, several of which go together to make up a program.

Software can be produced merely by writing the instructions with pen and paper, but in order to test and actually use the software, it must also be typed into a computer. Hardware as well as labour is therefore a necessary input to the software production process. The instructions which make up the software can be written in a number of different *computer languages*; typical examples of such languages are BASIC, COBOL and C. Using a programming language, software is initially written in a human-readable form, called *source code*. This is then translated into a computer-readable string of ones and zeros, called *object code*, which operates the computer (Correa 1985:4-5).

There are also *software tools* available which, with a minimum of commands, can generate software instructions automatically. Software languages and software tools are therefore also found as inputs to the software production process, and are studied in greater depth in chapter 5.

Because of the close and essential relationship between hardware and software (see also Correa 1985:49 and O'Connor 1985), and despite the fact that the principal focus of this research is on software, it was clear that any study of software would be incomplete without some investigation of hardware production. Hardware is therefore covered in chapters 5 and 6.

The software production process must be managed. One of the ways in which this has been done is by breaking the process up into a series of differentiated, standardised steps or stages: *Analysis* of the problem - *Design* of the software - *Coding*/writing of the software - *Testing* of the software - *Delivery* - Subsequent *maintenance*. This differentiation has allowed a set of different job roles to arise in connection with software production including *Project Manager*, *Analyst*, *Designer*, and *Programmer* (who does coding and testing). It is generally accepted that project management and analysis are more skilled tasks than design which, in turn, is a more skilled task than programming.

The software produced can be divided into two basic categories. *Applications software* is 'Programs ... designed to carry out specific tasks, or applications; as distinct from *systems software*, which controls the operation of the total computer system.' (Meadows et al 1987:16). Typical applications software includes word processing programs or database programs, whereas systems software consists of *compilers* (which translate software language instructions into machine language instructions which the computer can 'obey') and *operating systems* (which act as the interface between the computer and the computer user, and between the computer and the applications programs).

Software may be produced for general sale to a large number of users, in which case the product is known as a *software package*, or it may be produced for a single, specific customer, in which case the product is known as *custom software.* In the discussion that follows, 'custom software' will also be used to describe standard packages modified to suit a particular client's needs, though this is sometimes referred to separately as *customised software* (UNIDO Secretariat 1983:31, Correa 1985:89). *Customised conversion* work involves the conversion of existing software running on one type of computer to run on a different type. In the process the software may also be enhanced.

For the purposes of the discussion that follows, software packages will be regarded as goods while custom software will accepted as constituting a service. Arguments about definitions of goods and services will not be pursued in any depth because, as Sauvant (1986:82) notes, 'the boundaries between data services and other goods and services are blurring, and the designation of an increasing number of products as "goods" or "data services" becomes a matter of choice'.

The group of companies which produce software will be referred to collectively as the 'software industry'. This term will be taken to include those companies or company divisions which earn the majority of their revenue from sales of software consultancy services or software packages. There will be little focus on the other sources of software such as in-house software development, and production within end user organisations or hardware companies (Correa 1985:13-19), because production has been much greater from the 'software industry' in the case chosen, because of the difficulty and expense of obtaining information on these other sources, and because policy has not been addressed specifically to them.

4. Choice of the Indian software industry

Because work on developing country software industries has been so rare, it was felt that this study should attempt to draw its conclusions from a detailed study of software industry development. The breadth and detail of study required and the limits to available research time determined that only one country's industry could be studied in any depth.

For a study of the interplay between policy liberalisation and software industry growth, India was the obvious choice of study site because it has one of, if not the, longest-established and largest software industries in the Third World (compared to those in Brazil (Gaio 1989), China (Baark 1990), Singapore or Taiwan (Schware 1989)). It has also had a software policy since 1970; much longer than other developing countries.

India's software policy has continually stressed export orientation, but was substantially liberalised during the mid-1980s when software was identified as a thrust area (EI&P 1985b). The relatively long history of both policy and industry can provide valuable lessons for other countries looking for guidelines on software policy.

The case is also of interest because of the industry's export orientation. There is an argument (implicit within the work of Schware (1987), explicit within Fialkowski (1990)) that a strong domestic-oriented software industry is required before a country can move into exports, because this will form the site on which to build up software production skills and capabilities. The experience of the Indian industry appears to contradict this argument and allows conclusions to be drawn about the desirability and consequences of an export-, as opposed to domestic-oriented, development path for software industries.

Although the state policies relating to many Indian industries were liberalised during the 1980s, particularly after 1984 when Rajiv Gandhi became Prime Minister, those relating to software represent some of the most liberalised (see chapter 2). This study therefore presents an interesting contrast to the typical picture of Indian industry, which has been seen as inward-looking, protected, working within an environment of all-pervasive government controls, and using obsolescent technology (e.g. Lall 1987:23, Singh & Ghosh 1988). The study is valuable given the size and importance of India's industrial base and that liberalisation has been seen by some as the panacea for India's economic ills (Henseleit 1987, Jha 1987).

The study is of added interest since it can be seen to represent the quintessence of Rajiv Gandhi's period in office, which was strongly associated with both policy liberalisation and modernisation through use of information technology, at least in its initial stages (e.g. Datt 1987a:vi, Manor 1987, Kohli 1989a).

5. Overall question

Having identified the key industrial policy issue, a key industry and an appropriate case study, the central question this thesis seeks to answer is:

How has the development of the Indian software industry been affected by liberalisation of state policy?

The study will also attempt to draw some more general conclusions about policies for successful software industry development in developing countries, and there will be a particular interest in export orientation - its implications in general and as a path for software industry development. However, state policy is not the only factor to have an impact on industrial development and technological, macroeconomic and political factors will also be considered.

The answer to the question posed will not be sought in strict economic terms because the limited depth and validity of available quantitative data does not permit this, and because a viewpoint restricted to economic factors is far too narrow to obtain a true understanding of industrial development. Rather, this study draws out the consequences of certain policy actions in terms of some of the measures listed above and aims to offer a better understanding of the nature of the industry, its markets, and of policy making.

6. Data sources

This section deals with the way in which data was gathered in seeking to answer the thesis question. The aim of the fieldwork was to understand the theory and reality of Indian government software policy, and to assess its impact on software exports and on wider measures of industrial development.

The only officially published data relating to the Indian software industry consists of those government policy measures which relate to software; the annual level of software exports from India; and the number of software firms registered with the Department of Electronics. This official data suffered two main limitations in addressing the thesis question.

Firstly, it was of uncertain quality. The export data relies on reports from individual firms, which may have reasons for deliberately or accidentally over- or under-estimating their earnings. Official policy statements can also differ from the reality of policy implementation.

Secondly, it provided nowhere near enough information. In order to understand industrial development, far more than just data on exports and number of registered firms was required. Qualitative data was also required on the mechanisms and issues underlying the impact of policy and the workings of the industry.

While secondary sources can provide some of this information, it was felt that primary data had to be gathered by interview and survey from a variety of sources. The fieldwork was divided into two main periods - a 6-week initial pilot study during January-March 1988, and a 6-month full fieldwork period from November 1988-May 1989. Some additional work was briefly carried out in November 1989.

In all, a total of 165 interviews were conducted (of which 14 involved seeing the same person on both pilot and main fieldwork) in over 100 organisations. A full list of the organisations surveyed is given in Appendix A. Of the 158 interviewees, 99 were drawn from Indian software companies. Because of the particular research interest in software exports, it was decided not to choose a sample of companies, but to cover as many of the largest exporters as was feasible.

27 of the top 30 exporters of 1988 were surveyed, representing over 98% of India's software exports. Because the sample of firms chosen so comprehensively covered the export-oriented arm of the industry, findings from surveying the firms are taken to represent the trends within that part of the industry overall.

To offer some balance a number of very small or would-be export companies were also contacted, as were some domestic-oriented firms. The smaller firms were chosen at random from a list of all registered firms and to these were added the largest domestic-oriented company and those which were relatively more active or successful according to Indian computer journals. None of the individuals or firms contacted declined to be interviewed, though some did decline to give certain statistical information. In all, 50 Indian software firms were contacted, with a breakdown as shown in Table 1.1.

Table 1.1

Indian software firms surveyed

Firm type	No. of firms possible	No. of firms contacted	No. of interviewees
Top 2 exporters of 1988	2	2	22
3rd-10th exporters	8	8	18
11th-30th exporters	20	17	28
Smaller exporters	c.120	10	15
Domestic-oriented	c.500	13	16

As indicated in table 1.2, a range of different types of staff was interviewed within the software companies in order to obtain a cross-section of views. Because of the focus on policy, strategy and company performance, there was a strong bias towards top and higher management in those chosen to be interviewed because programmers knew much less about these issues.

Table 1.2

Indian software company interviewees

Interviewee type	Number interviewed
Director/Board member	24
High-level manager (e.g. Deputy General Manager)	24
Administration manager (dealing with government)	10
Marketing manager	14
Software project manager	15
Systems analyst	5
Programmer	7

Managers were contacted at five other producer companies - four of the leading hardware manufacturers, and one of the leading component manufacturers. A total of seven managers was also interviewed in five of the leading public sector users of local and imported software and hardware.

27 governmental representatives were interviewed. Of these, seven had had a direct policy-making role as regards software, and a further six worked in central government departments on matters relating to the electronics industry. Eight others worked in semi-autonomous bodies such as the ExIm Bank, the Industrial Credit and Investment Corporation of India, and export processing zone administration. The remaining six

worked in offices in various parts of the country, such as Customs or import-export control, implementing software-related policy.

Three interviewees were drawn from the immigration and trade sections of the US and UK embassies. The person responsible for software matters in each of three industrial associations - Confederation of Engineering Industry, Manufacturers Association for Information Technology, and National Association of Software and Services Companies - was also interviewed.

Nine academics were contacted, four working on software research and training, five working on industrial policy. Finally, the editors of the two leading Indian computer journals plus three journalists were also interviewed.

In the UK, interviews were carried out with managers working for four of the leading software companies and three smaller ones concerning links with India and the global software market. Comparative interviews were also conducted with four programmers about their working conditions and use of new technology. Representatives of the UK National Computer Centre, Computer Services Association, and the journal Computing were also interviewed.

Two academic conferences on Information Technology in Asia were attended in India, as were three combined exhibitions and workshops promoting Indian software (one in India, two in the UK). At all of these a number of short discussions were held with participants from Indian and UK companies, and from the Indian government.

Interview details

In all, about a dozen different sets of interview questions were developed during the pilot visit, with each set being aimed at a different type of interviewee. The questions were used to form the basis of a semi-structured interview. The direction of the interview took its lead from those elements which seemed to particularly concern or interest the interviewee, but the list of questions was used to ensure that, at the end of the interview, a core set of issues had been covered. The interviews were used to gather both quantitative statistics and qualitative data.

The semi-structured interviews were recorded using a form of speedwriting. All important points or quotes (up to 100 per interview) were noted in summary form. In about a quarter of all cases, this initial analysis provoked a sufficient number of supplementary questions that a follow-up interview was conducted, usually by telephone.

A summary of findings was sent to over 50 of the main participants for comments. Only a dozen had responded at the time of writing but they were all positive about the summary and did not highlight any major misunderstandings.

The issue headings for interviews with the three most important groups - software managers, programmers/analysts and government policy makers - are given below.

Software managers:- Company background; company performance; perceived policy changes; policy making; impact of a range of policy measures; problems with policy; use of new technology; impact of technology on skills, exports, jobs, nature of work; links with multinationals.

Programmers/analysts:- Personal history; job content; impact of new technology.

Government policy makers:- Policy history; current policy measures; processes of policy making; interest groups; policy objectives; policy implementation; policy and new technology; export orientation and import substitution.

Observation material was also used, with time being spent watching programmers and project teams at work on software development, watching the interactions taking place within offices, and using some of the software and hardware products created by Indian companies.

Unless otherwise indicated, findings presented in the ensuing chapters have been drawn out from at least two differing interview perspectives (e.g. software manager and government official, or software manager and programmer), with supporting evidence from a secondary source. In general, only the secondary source is explicitly referenced.

Secondary sources

Libraries, bookshops, government offices, journal and newspaper offices, and the companies surveyed were all used as sources of secondary material. Items gathered include:

i. Government documents. Official policy statements and notifications; interim, position, and discussion documents on policy; Parliamentary proceedings; government committee reports; promotional literature.
ii. Government statistics. From Department of Electronics annual reports; government journals (Electronics - Information & Planning, Software Development Agency

newsletter, Elsoftex newsletter, Electronics Exporters Bulletin); annual Economic Survey.

iii. Academic books.

iv. Academic journals.

v. Computer journals. All copies of the two principal Indian journals - Dataquest and Computers Today. These include other sets of statistics, analyses of policy, product reviews, state-of-the-industry reports, and news items. Also copies of the UK journal Computing.

vi. Other Indian journals. Including Economic and Political Weekly, and India Today.

vii. Newspaper cuttings libraries. Times of India; Economic Times; Deccan Herald.

viii. Industrial analysis reports and newsletters. Prepared by International Data Corporation (India).

ix. Company annual reports. These include sets of statistics.

x. Company brochures and other product details and reviews.

7. Thesis argument

In this thesis it is argued that policy makers in developing countries seeking to create policies for software industry development face two principal decisions. Firstly, over the degree to which software production will be oriented towards export or domestic markets, and secondly over the degree to which liberal or interventionist policies will help achieve the developmental objectives.

It will be shown that home government policy is by no means the sole determinant of software industry development because there are many other factors which help to shape industrial development. These include foreign government policy; the nature of the technologies involved; features of producer-consumer relations; and various market entry barriers and input supply constraints. Nevertheless, policy can be seen to have had an important impact on industrial development, so that policy-making decisions do help to decide how and whether an industry develops.

Much of the thesis concerns itself with the impact that policy liberalisation can be seen to have had on the Indian software industry. It will be argued that, while certain policy liberalisations have a place in industrial development, liberalisation is by no means a 'panacea' for such development and that, as such, the neo-liberal model (though also the structuralist model) is wholly inadequate both to prescribe policies for, and to explain industrial development.

It will be seen that certain liberalisations enacted in certain circumstances can be a necessary, though not sufficient, condition to assist the quantitative growth of an industry and to help increase the supply of relatively scarce production inputs. However, liberalisations have also led to stagnation; to dependence on foreign skills and technology; to balance of payments problems; and to a loss of local technological capabilities and self-determination.

At the same time, even in this significantly-liberalised, technologically-unusual industry, certain government interventions have been found to play a necessary (though, again, probably not sufficient) role in industrial development by helping to create more balanced and independent development than could be achieved through 'leaving it to the market', and by overcoming entry barriers and input constraints.

It will be argued that, through a detailed understanding of the way in which policy is made, it becomes clear that policy choices are not made on objective economic grounds, but are constrained by external factors, by the nature of the technology involved and, above all, by the Indian political economy. The nature of the political economy is such that it demands compromises between groups, and this has made sweeping liberalisation unfeasible in the Indian context.

Some writers, whose arguments have been summarised above, have tended to adopt rather polarised positions about policy, and this has been particularly true of those discussing Indian industrial policy (Hussain 1987:369). In this case study it will be argued that a more qualified approach is required, with neither the structuralist nor the neo-liberal models providing the blueprint for growth, and with neither model being supported by the available evidence.

Policy prescriptions cannot, therefore, be derived dogmatically from either of the models described. Instead, software industry development will require a mixture of intervention and liberalisation, with the nature of the mixture being determined by response to the specific and changing circumstances that affect the particular industry involved.

As regards the second issue of export or domestic orientation, it will be argued that the Indian industry has shown a strong bias towards production for export, thanks to a mixture of market factors and policy encouragement. While this approach has brought some overt quantitative gains, deeper analysis reveals that this growth has been largely low-skilled and dependent on foreign firms, and that it has adversely neglected the domestic market except where government has specifically intervened.

Within the Indian software industry, then, there is a need for greater balance between export- and domestic-oriented production, such that neither is advantaged to the detriment of the other. In the case of other developing countries, it may well be that they will benefit more from a significant domestic market focus rather than by attempting to follow India's export-led and export-biased lead.

8. Thesis structure

Chapter 1 has reviewed the literature on industrial policy in developing countries, drawing out the importance of the software industry and of certain policy issues which combine to form the central research question of the thesis.

Since policy forms a central concern of this research, it is firstly necessary to review the Indian government's policy towards the software industry, and to place it within the industrial policy framework already offered, assessing the degree to which it has been liberalised and in what ways. This is undertaken in *chapter 2.*

Having described policy, the manner in which the industry has developed needs to be known. *Chapter 3* outlines the performance of the Indian software industry according to publicly-available quantitative measures, but then looks behind these at some of the qualitative data gathered.

From chapters 2 and 3, it emerges that, although there is an overall policy impact, one can best understand the effect of policy by studying discrete policy areas. Chapters 4 to 8 cover such discrete areas. They form the core of the thesis and address the relationship between policy, industrial development and the market, assessing the developments on *which policy does, and does not, have an impact. The choice of policy area is* taken from the framework suggested above (from Weiss 1988 and Fransman 1986), which fits well with the policy areas contained within India's software policy.

Chapter 4 seeks to explain the developmental data outlined in chapter 3. It deals with government controls and guidance over the direction of industrial production, and assesses the impact of controls on industrial licensing and production capacity, as well as the incentives used to try to push firms into exports. In undertaking this assessment, it is necessary to understand the factors determining why and how firms enter and expand in domestic- and export-oriented production.

Controls over imports are covered by *chapters 5 and 6*, which assess the importance of policy in determining import behaviour, and the impact of import liberalisation on local consumers and local producers of both hardware and software.

Foreign collaboration and investment have played an important role in the development of the Indian software industry and *chapter 7* describes some of the ways in which such collaboration occurs and assesses some of the costs and benefits of it, particularly in relation to the barriers and constraints described in chapter 4.

Chapter 8 complements chapter 7 by looking at ways in which the Indian government has attempted to overcome software industry development barriers and constraints. Unlike chapters 4 to 7, chapter 8 therefore deals not with liberalisation but with government intervention.

It was noted above that considerations of *political economy are important in trying to* understand policy. *Chapter 9* looks at the political processes that underlie the formation of software policy in an attempt to understand the political and other factors that constrain the direction of policy changes.

Finally, some conclusions on software industry development, liberalisation and software policy in general are presented in *chapter 10.*

CHAPTER 2

POLICY AND LIBERALISATION

Introduction

The purpose of this chapter is to describe the policies that have affected the Indian software and hardware industries and to assess the degree to which policy changes can be said to represent 'liberalisation' as described in chapter 1. In that chapter, it was suggested that software policy is one of the most liberalised policies. In order to see whether this is true, it will first be necessary to briefly describe the overall framework and chronology of Indian industrial policy since independence.

1. Indian industrial policy

1.1. Overall framework

In general, 'Indian industrial policy has been statist, protectionist and regulatory.' (Rubin 1985), and takes as its main reference point the 1956 Industrial Policy Resolution. This indicated that there was to be a clear role in industrial development for the public sector and state investment (especially in infrastructural and heavy industry development), with a large degree of state planning for industrialisation, but within what was to be fundamentally a capitalist economy which retained a controlled role for private and foreign ownership (Lal 1986). Priority was given to heavy industry and growth through import substitution.

Indian state intervention in industrial development has been extensive and made up of a number of elements[1].

i. Import and export policy. In line with import substitution policies, the Indian government has used import bans, quotas, tariffs and an exchange rate policy. Foreign technology import agreements have been controlled through regulations on permissible royalties, agreement length, and restrictions on subsequent exports.

[1] List compiled from Fransman (1986:96-101), Ahluwalia (1988), Singh & Ghosh (1988), Martinussen (1988) and Harriss (1989).

ii. Industrial entry and expansion. 'The Industrial Development and Regulation Act of 1951 entails that any enterprise which wishes to manufacture a new article or seeks a substantial expansion of its existing capacity must obtain a licence from the relevant government authorities.' (Singh & Ghosh 1988). Licensing was also used to reserve production of certain items for either small-scale or public sector producers, and to prevent very large corporations entering into certain industries. This latter measure came into force via the provisions of the 1969 Monopolies and Restrictive Trade Practices (MRTP) act. Most recently, MRTP companies were defined as those supplying more than 70% of a particular product market or having more than Rs.1000m (c.US$57m at 1990 prices) of assets (Das Gupta 1990).

iii. Foreign investment policy. The main regulation used has been the 1973 Foreign Exchange Regulation Act (FERA), which effectively limits foreign equity holdings in India-based companies to 40% unless specific exceptions are made, such as for companies which are solely oriented to exports.

iv. Sectoral prioritisation. Certain industrial sectors have been prioritised by direct public investment, by provision of finance from state financial institutions, by allowing easier access to imports, and by faster bureaucratic processing.

v. Procurement policies. Indian industry can be favoured by regulations encouraging government and public sector bodies to purchase from local sources.

vi. Infrastructural provision. Government has invested in transport, energy, communications, and water infrastructure. Finance has also been provided for the development of skills and technological capability through training, and research and development (R&D).

vii. Administered prices. The government has fixed prices for so-called 'essential' products.

viii. Other. The Indian government has also intervened in industrial relations disputes and, more generally, through the business decisions of public sector firms.

1.2. Chronology

Though the policy elements described above have been present throughout India's post-independence industrial development, there have been changes in policy strategy over time.

Pre-1975

During this period there was extensive government intervention in industrial development through the instruments listed above, with an overriding emphasis on import substitution and self-reliance through a combination of ideological, economic and pragmatic considerations (such as the severe foreign exchange shortage). There were some signs, especially from the mid-1960s onwards, of a greater emphasis on exports[2] and a reduced emphasis on planning, but the major elements of government policy and action remained largely unchanged throughout this period (GoI 1987e, Harriss 1989).

1975-1984

This was a period of policy re-evaluation and change during which a number of expert panels, such as the Alexander Committee, Sondhi Committee, and Jha Commission, considered the problems facing the Indian economy and suggested policy liberalisations as ways to alleviate the problems (GoI 1987e). Partly as a result, liberalisation measures 'were introduced very gradually from the mid-1970s, with many of them, particularly import liberalisation, taking effect only in the late 1970s and early 1980s.' (Singh & Ghosh 1988). Under Indira Gandhi, liberalisation was generally quite limited, but industrial policy changes included a general move from physical to financial controls; a reduction in import quotas and tariffs; a relaxation in industrial entry and expansion controls; and the decontrol of some prices (Rubin 1985, Kohli 1989a).

Post-1984

When Rajiv Gandhi came to power in 1984 he and his technocratic coterie[3] continued the liberalisation process already in motion, but gave it added impetus:

> "These modifications of economic policy began in an evolutionary way in the mid-1970s. However, they have gained real momentum in the last two years particularly since Rajiv Gandhi became prime minister." (Singh & Ghosh 1988)

The true nature of change was hard to ascertain. Some commentators felt that 'No one visiting India from any genuinely open economy will believe that anything resembling real change has been brought about" (India Today 1988). This feeling was reinforced by the continual output of structuralist rhetoric in which politicians like the Prime Minister would 'reaffirm adherence to socialism and planning' (Times of India 1984), and claim

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[2] For example, the creation of two export processing zones.

[3] Including then Home Minister Arun Nehru, Defence Minister Arun Singh, and Finance Minister VP Singh.

that there was 'no drifting from 1956 industrial policy resolution' (Times of India 1985b). Yet other commentators went to the opposite extreme and claimed to see 'reliance on market forces and free enterprise' (BM 1988).

In reality, there were genuine liberalisations, but these never came close to any of the neo-liberal extremes. The liberalisations were mainly introduced in 1985 - in the budget, the new import-export policy, and the new fiscal policy - and they cover five main areas[4]:

General

- administrative improvements to reduce delays for import and industrial clearances, including those for foreign collaborations
- a reduced role for the Planning Commission thanks to the creation of a Ministry of Programme Implementation

Trade

- replacement of some import quotas with tariffs
- reduction of some import tariffs, including those for capital goods
- some currency devaluation

State control

- delicensing of entry into some industries
- reduction in the scope of the MRTP act, by raising asset threshold
- greater scope for expansion without requiring a new licence
- more 'broadbanding', which allows some flexibility to use installed capacity to produce alternative products
- reduction of price controls on some goods
- lowering of corporate taxes

Foreign investment

- greater scope for expansion and diversification by FERA companies
- increased equity allowances for certain foreign collaborations

Ownership

- permission for entry of private sector firms into certain areas previously reserved for the public sector

[4] List compiled from Singh & Ghosh (1988), Wadhya (1988) and Kohli (1989a).

Although wide-ranging, the changes were much more often quantitative (i.e. a reduction) rather than qualitative (i.e. a removal), and India never approached a 'free market' situation - the state always retained extensive controls over most of the elements listed above. In overall terms, 'A liberal model of development has not yet replaced the mixed economy model premised on state controls and import substitution.' (Kohli 1989a). Liberalisation was particularly seen in the area of industrial entry and expansion; somewhat less as regards trade; less still over foreign investment; and with hardly any change in terms of public and private ownership.

Even this relatively limited process of liberalisation did not last very long and, by 1987, it had faltered (Badhwar and Chawla 1988) and even begun to be reversed. Kohli (1989a) therefore isolates three phases of the policy liberalisation process that occurred during Rajiv Gandhi's term in office.

> "During the first six months of his rule, there was a genuine attempt at a new beginning ... The next two years are best characterized as two steps forward toward and one step backward from the defined agenda ... May 1987 marked the beginning of the third and the present phase. This is the return to India's "muddle through" model of economic policy making." (Kohli 1989a)

1.3. Technology policy

Science and technology have always been seen to have an important role within India's industrial development, with the importance of technology for modernisation being stressed since the earliest post-independence days (Aiyar 1988). Spurred on by Nehru's 'personal interest', a Scientific Policy Resolution was adopted in 1958, which stressed the need for self-reliance and the building-up of local technological capability (Ahmad 1985). In the 1950s and early 1960s, technology import policy was quite liberal in order to provide a base on which to build local capabilities, but from the mid-1960s onwards there was greater selectivity (Alam 1985).

There were some signs of change in the 1983 Technology Policy Statement, which stressed self-reliance, but also the importance of international competitiveness and of exports (Lok Sabha Secretariat 1987:10-11).

Under Rajiv Gandhi, science and technology were pushed even more to the fore. He stressed the importance of new technology and indicated his own interest in science and technology by creating a new Science Advisory Council; by creating 10 'technology missions' for the country; and by taking direct charge at some point of the Ministries or Departments of

Science and Technology, Electronics, Atomic Energy, and Space (Times of India 1985c, Times of India 1985d, Lok Sabha Secretariat 1987:35-36).

As with economic policy as a whole in the latter half of the 1980s, there was a partial change, away from modernisation through import substitution and more towards modernisation through import liberalisation and export orientation (Times of India 1985a, Singh & Ghosh 1988, Business Standard 1989).

1.4. Summary

Both industrial and technology policy in India followed a broadly structuralist model during the first twenty or so years of independence. From the mid-1970s onwards, and particularly after 1984, there has been a process of policy liberalisation. However, this has progressed farther and faster in some policy areas than in others, and has never come close to approaching the neo-liberal model. In late 1985, the processes of both liberalisation and technology modernisation began to slow, with the former having been slightly reversed in some areas in the final years of the 1980s.

From this description, one can move on to ask - 'How do India's software policy and policy changes compare to the picture of general policy already presented?'.

2. Indian software policy

Pre-1980: building software exports

During the 1970s, government software policy restricted itself largely to the question of providing imported hardware for would-be software exporters. In mid-1970, a Department of Electronics (DoE) was created, with a remit which included the software industry and software industry policy. Three months later, in September 1970, a largely unsuccessful 'programme for promoting the generation of computer software, particularly for export' came into existence (EI&P 1984b).

It was revamped in 1972 as the 'Software Export Scheme' (GoI 1987c:12), allowing hardware to be imported for use in software export work. The main condition attached was that the importer had a commitment to earn twice (200%) the import price of the computer in foreign exchange via software export within the following five years. This facility was first used in 1974 (GoI 1975a:57).

Other policy elements begun in the early 1970s and which continue to the time of writing include:

i. Investment by the Department of Electronics in public sector R&D projects which involved software development.

ii. Software procurement. There has been no legally laid down procurement policy as regards software, but most public sector contracts for custom software development have been given to Indian companies though, by contrast, most contracts for software packages have asked for imported goods.

iii. Government encouragement and initiation of computing and software-related training courses in universities and similar institutions. The training policy has been continually updated and expanded.

In June 1976, policy was partly liberalised, but mainly expanded and relaunched. Hardware import duties were reduced from over 100% to around 40%; banks were advised to extend loans for software projects; and software exporters were promised faster clearance of their applications (Grieco 1984:130, GoI 1976:12). A new scheme was created so that Indians living overseas (non-resident Indians - NRIs) could pay to import computers for software export and only take on a 100% export commitment (EI&P 1984b).

It was also made clear that software was eligible for export incentives such as location of production in export processing zones, tax concessions, and the export subsidy of cash compensatory support (first offered at a rate of 10% of the value of software exported).

1980-1984: punishing misusers

By 1980, it had become clear that many computers imported under software export schemes were actually being leased out for domestic market use. New policy guidelines were therefore issued in January 1981 which, in theory, emphasised 'the generation and export of software using the existing computer capacity in the country, rather than ... the import of computers' (EI&P 1984b). The actual policy was rather contradictory.

Import duties were raised, and tighter government inspection controls established (at least in theory), with the threat that the DoE could confiscate computers if importers defaulted on their export commitments. At the same time, it was recognised that an imported computer's full capacity could not all be taken up with export-related work, so the new policy loosened controls by allowing firms to use two-thirds of their machine time on domestic work with the other one third dedicated to exports.

Export commitments (now called export obligations) remained the same for category A (ordinary import) and category B (import by NRIs) but category C was added, which allowed the import of loaned hardware, with only limited export obligation or import duty.

From 1982-84, the DoE tried to push most software exporters into importing computers on loan basis, under Category C, and only a handful of these were even allowed (Dataquest 1983a, Khanna 1984). The whole process was also painfully slow - 'the Department of Electronics built up a history of delays and confusion that must have had few parallels, even in this country', with computer import applications taking 'over two years' (EPW 1984b).

This tightening of one element of import policy was a reaction to the perceived misuse of computer imports at a time when the government wanted to build up the local hardware industry. This did not affect the DoE's training and investment efforts, nor the desire to promote exports. For example, it was during this period that the Engineering Export Promotion Council, later joined by the Trade Development Authority, began offering export marketing assistance to software companies.

1984-1986: liberalisation

By 1984, it had become clear that policy was not keeping up with the development of the industry. As one journalist noted, 'The government saw that software development was on the increase, and so felt they needed a formal policy'. The new Computer Policy (GoI 1984b) was some eight months in the making, but it was issued on 19 November 1984, just a few days after Rajiv Gandhi was appointed Prime Minister.

While the main thrust of this policy was towards hardware, some major policy liberalisations were directed at the software industry. In trade terms, the procedures for importing hardware became quicker and easier. Imports also became cheaper as basic customs duty on hardware was reduced from 135% to 60% and on software from 100% to 60%, with an allowance of duty-free import for source code on paper. Other measures were announced aimed at improving access to imported software and spares (Financial Express 1984c).

As regards state controls and foreign investment, software was recognised as an industry and entry into the industry was delicensed. As with hardware, companies with up to 40% foreign equity holdings (covered by FERA) and very large companies (covered by the MRTP act) were allowed to become software producers.

There were also some interventions and promotional aspects. Software was placed under the Copyright Act, bringing the threat of fines or imprisonment for software pirates. A Software Development Promotion Agency was planned, and 50% of software export earnings over and above obligation in any given year could be used for a foreign exchange permit to buy a range of goods, including more computers, in following years. The only negative outcome for software was that the income tax exemption on net export earnings was reduced from 100% to 50%.

The policy, at least in its theory, was almost entirely one of liberalisation for software because it made imports of hardware and software, entry into the industry, and access to foreign exchange easier. Yet a senior government official also announced that there would soon be a new software-only policy which would be 'more liberal and would contain innovative ideas' (EEPC 1985). It was intended to be a 'freewheeling, flood in, flood out policy' (Menon 1987), allowing a liberalised 'flood in' of imports which would then be followed by a 'flood out' of exports in order to reach the target of Rs.3000m (US$260m at 1984 prices) gross foreign exchange earnings from software exports by 1989/90 (Raman 1985).

1986: give and take

However, when the Computer Software Export, Software Development and Training policy duly appeared in 1986 (GoI 1986b), it gave with one hand, but took away with the other. Import of hardware was made easier and quicker through some procedural changes, and regulations about domestic-oriented use of imported hardware were dropped. The import of software was also delicensed (changed from quota to tariff protection) so that anyone could import it if they paid the 60% import duty[5]. On the other hand, hardware imports became more risky because the attached export obligations were strengthened. In general, the obligations increased by 50%; had to be achieved in four years rather than five; were to be more stringently adhered to using bonds and bank guarantees; and had to be earned from net rather than gross export earnings.

Similarly, foreign exchange was made available via annual rather than individual permit, but permit size was reduced from 50% to 30% of the previous year's foreign exchange earnings in excess of any export obligation. Cash compensatory support was raised from 8% to 10%. It was also confirmed that wholly foreign-owned software companies could be set up, so long as their entire output was sold as exports and not to the domestic market. This was not actually a policy change, but several regulations had to be altered in order to permit this, particularly in regard to export via satellite link (Poe 1987). More

[5] Software is therefore said to be imported on Open General Licence (OGL).

importantly, the policy implementation procedures were altered to speed up foreign company applications.

1987-1990: lack of direction

In the period following the 1986 policy, a number of clarifications were announced which gave rise to a feeling of loss of direction within policy. The changes covered three main areas.

Trade

Indian companies were allowed to become distributors for foreign software - a process known as 'stock and sale' - but this privilege was effectively restricted to large software exporters only in early 1987, excluding the trading and hardware companies which had earlier hoped to become software distributors (Raju 1987).

Large software companies also benefited from a ruling in 1988 that any company exporting more than Rs.100m (c.US$5.7m at 1990 prices) of software per year could pay off its export obligations in whatever manner it chose. Smaller companies were restricted to exports that made use of the imported computer which had attracted the obligation in the first place (GoI 1988c). This policy change is known as the '10 crore rule'[6].

In July 1988, an earlier decision to ban the import of loaned computer systems was reversed. Such systems could be imported for between six months and one year, with a 50% export obligation, 25% bank guarantee and 20% import duty. If the computer was returned within six months the export obligation dropped to 25% (GoI 1988d).

The 1988/89 budget permitted accompanying software and start-up spares imported under the software export policy to have duty levied at the same rate as the main hardware, rather than the 250-300% previously used (Sharma 1988). However, in 1988, the ability to import source code software on paper without paying duty was dropped because of perceived misuse and, in June 1989, import duty on software was raised to 107% (Dataquest 1989j).

State controls

Since 1987, software companies have had to register with the Department of Electronics to receive certain export promotion assistance. The threshold for those eligible to register was reduced from Rs.5m in 1987 to Rs.1m in 1988 and to Rs.0.2m in 1989 (Raju 1987, Dataquest 1989p).

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[6] 1 crore is a numerical measure used in India which represents 10 million.

In the 1987/88 budget, it was announced that there would be a 15% tax levied on all outgoings of foreign exchange associated with travel overseas. This affected the software industry quite considerably because of its spending on travel and living allowances for software developers working at their clients' sites.

Software industry perceptions of bureaucratic muddling and meddling were confirmed in the 1988/89 budget. In this, the 'liberalisation' was announced by the Ministry of Finance (MoF) that excise duty on software was being reduced from 25% to 10%. Had MoF bureaucrats taken the trouble to contact their colleagues in the Department of Electronics, they would have discovered that software had been ruled exempt from excise taxes for the previous two years (Khanna 1988a). They had to retract the measure soon after.

Promotional measures and interventions

The DoE's Software Development Agency was set up in 1986 with the aim of co-ordinating formulation and implementation of software-related policy measures, and of promoting the development of the software industry. *In 1988, a separate Electronics and Software* Export Promotion Council was created to help increase Indian exports of electronics goods and software, mainly by helping with marketing.

In 1987, an insurance scheme was introduced to cover the clients of Indian software companies against malpractice or lapses, and export shipment credit and credit guarantees were made available (ExIm Bank 1989b). In April 1988, a one year visa for visiting trainers from overseas was announced. Venture capital funding for software companies also became available (ESC 1988:49), as did overseas telecommunications links (Darshini 1989b).

In April 1989, payments of the export subsidy Cash Compensatory Support were suspended for about a month in an effort to force companies to make their annual returns to government of financial data. A year later, payment rules were simplified to make it easier to claim the subsidy on a regular basis (Dataquest 1990n).

Finally, late in 1990, the software industry was once again wholly exempted from tax on export profits (Dataquest 1990y).

Policy and Implementation

Industrial policy should be conceived as a set of explicit or implicit industrial development objectives and ought not to be confused with lists of measures written on paper (see Marathe 1989:165). Nevertheless, it is mainly through an analysis of these measures that one comes to recognise implicit objectives, though explicit statements are also made occasionally. Software policy objectives are discussed in a later section.

However, rather than policy objectives or policy measures on paper, it is policy as actually implemented by state officials which mainly affects industrial development and which is the main policy focus of this thesis (though the 'form' of policy also matters). If changes to policy on paper (the theory) are quite different from implemented policy (the practice), the measures listed above will be of little significance.

The main feature of implementation has been that it is conservative, tending to attenuate policy changes and thus moderate the extent of liberalisation. For example, in 1986 it was promised that there would be a 'single point clearance' for hardware import applications and that decisions would be made 'within six weeks' (GoI 1986b). In reality, the process requires visits to at least two government departments and takes about three months[7]. Similarly, while entry into the software industry is delicensed, companies still have to register with the Secretariat for Industrial Approvals (ESC 1988:11).

However, in these cases and others, the overall change in policy has overshadowed these minor implementation alterations. Policy in practice has therefore been sufficiently close to policy in theory for the changes detailed above to be taken as those which actually affect the industry[8].

2.1. Indian software policy and liberalisation

Having described the changes seen in software policy in the twenty years from 1970 to 1990, one may ask to what extent these changes can be described as liberalisation.

Inward-looking ... Outward-looking

There has been some degree of liberalisation. The process has been strongest as regards software imports, which were delicensed in 1986, though the tariffs were increased in 1989. Hardware imports remain linked to a quota system, though there has been a good deal of procedural and tariff liberalisation since the 1970s, particularly in the latter half of the 1980s and despite the reversals of the early 1980s.

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7 See also Chandra (1987).

8 A number of policy changes that were never implemented, such as plans for a series of Indian Institutes of Information Technology (GoI 1986b), have not been included in the policy details given above.

As regards the export incentives recommended by the neo-liberal approach, these have been present for some time in the form of cash compensatory support, export obligations and foreign exchange permits. Economy-wide measures such as export processing zones, exchange rate devaluation, and tax concessions on export earnings also apply to software exports. These have shown mixed changes. Software-specific measures have become rather less liberal during the 1980s, while general measures have become rather more so.

State ... Market

Contrary to the prescriptions of liberalisation, there has been an increasing role taken by the state in the provision of finance, skills, infrastructure, legal regulation, and marketing assistance, particularly since the mid-1980s. There have also been continuous interventions in the form of procurement of custom software from local companies. By contrast, there was a significant liberalisation of controls over industrial entry and production capacity in 1984.

Anti-foreign Investment ... Pro-foreign Investment

While there has been no change in overall rules governing this area, both the 1984 and 1986 policies contained measures aimed at encouraging greater foreign investment in the Indian software industry, and procedural barriers were decreased.

Public ownership ... Private ownership

While there are claims of some policy implementation favouritism towards India's one public sector company within the software industry, there have been no significant policy measures aimed at increasing or decreasing its role. Such policy measures have been suggested from time to time (e.g. EI&P 1986b), but have not come to fruition.

Summary

Judging the changes in software policy over the past 20 years, one can talk only in the very loosest terms of a broad trend of liberalisation rather than the reverse, because the trend has been very patchy and has progressed quite far in some areas, yet hardly at all in others. Summarising the situation in the latter half of the 1980s, when the software industry showed its strongest growth, one can draw the following summary of policy areas:

Liberal - controls on industrial entry and production capacity.
Fairly liberal - software imports; export incentives (though, of course, these actually involve government intervention).
Partly liberal, partly controlled - foreign collaboration; hardware imports.
Not very liberal - finance; training; infrastructure; legal regulation; marketing assistance; software procurement.

The variation in both the extent and the timing of liberalisation suggests the need to focus on particular policy areas, rather than policy as a whole, when trying to understand the impact that policy liberalisation has had. With this in mind, each of the chapters in the main body of the thesis looks at a particular policy area. More than this, the study must focus on the reality of policy implementation rather than just policy changes on paper. For example, in the case of both hardware import and foreign collaboration changes in procedural implementation and bureaucratic attitude have been just as important as written policies.

2.2. Comparison to overall industrial policy

In comparing software policy to other policies, one can consider three main factors:

i. Policy changes

The trends in policy change within software have broadly followed the trends in overall industrial and technology policy outlined above, with some initial liberalisation in the late 1970s, more substantial liberalisation in the mid-1980s, and then a period of relative stability. Whatever hopes there may have been that the software industry might somehow be different from other Indian industries are certainly not reflected in the trends of policy change. In the post-1984 period, these trends quite closely follow the phases suggested by Kohli (1989a).

The 1984 policy was liberalising in almost all its measures, as were all the policies announced in the first six months of Rajiv Gandhi's period in office. The 1986 policy liberalised some elements such as software import, but reversed liberalisations on foreign exchange allowances, export obligations, and 'stock and sale'. One can easily see this as representative of Kohli's 'two steps forward, one step backward' phase. So the 1986 policy, intended to focus on software industry liberalisation, was actually less liberal for software than its supposedly hardware-oriented predecessor in 1984.

Since mid-1987, there have been no significant policy direction changes, but substantial modification of existing measures. It is hard to classify these modifications. Some have suited a particular interest group, such as those on cash compensatory support and the 10 crore rule; others have been liberalising or slightly liberalising, such as those on spares, hardware loans and DoE registration; others still have moved away from liberalisation, such as the increases in software import duty, and the travel tax; and finally some have been promotional, such as those on venture capital, infrastructure, export credits, insurance and visas. One can therefore find some justification in seeing a lack of any overriding direction for policy change, at least along a Structuralist ... Neo-liberal axis, and in applying Kohli's idea of 'muddle through', which seems to be epitomised by the chaotic nature of the excise duty announcement.

Chapter 9 will seek to explain why these policy phases should have come about, via an understanding of the various interest groups which played a role in policy making.

II. Policy endpoints

While the trends of software policy *change* have been broadly in line with the changes in overall industrial policy, the actual *endpoints* of that change in terms of the policy measures themselves have been rather different. As already noted above, despite the liberalisations of India's industrial policy, state control and import substitution remain dominant within most sectors. While software policy has not ended up radically different, it has arguably lain at the neo-liberal edge of the range of industrial sector policies.

Although this is not a small industry, entry into software production and changes in size and type of production can be undertaken without the need for any government permission. Foreign investment has been encouraged and wholly foreign-owned companies are allowed in, albeit for export work only. One of the main products, in the form of software packages, and one of the main production inputs, in the form of software tools, can be imported on Open General Licence without government permission, or can be purchased locally from distributors. The government has had no plans for a dominant public sector role in this industry, and has not intervened in prices or industrial relations.

Of course, policy for this industry comes nowhere near a neo-liberal model. There are licence controls on hardware import and foreign investment, with ordinary software firms limited to 40% maximum foreign equity. All firms and all export contracts have to be registered with the government. There are still tariffs on imported software. There are also substantial interventions in the provision of finance, training, infrastructure and marketing assistance.

Even so, one can say that, in the Indian context, the software industry operates under one of the most liberal policy regimes, though the difference from other industries is one of degree rather than kind. It is therefore illustrative of the general process of policy change within India, but provides an extreme example of where that change might lead.

III. Policy objectives

As already noted, it is industrial development objectives that constitute the highest level of policy, and where software policy has differed quite radically from the bulk of Indian industrial policy is in government objectives vis-a-vis export and domestic sales. By and large, the government's principal objective has always been one of earning foreign exchange through software export as a way to help compensate for the costs of importing hardware and electronics items (GoI 1973:18, Lakha 1990). This objective has been continuous throughout the history of the industry, though it has been gradually strengthened through policy measures since the 1970s, only decreasing slightly after 1986 (see chapter 8).

Even within exports as a whole, software has been specially targetted. Software was seen as suitable for export promotion because of the large, growing world market; the perceived low investment requirements; and the availability of skilled, English-speaking, low-paid workers (GoI 1975a:57). It is an 'export thrust area', with government having set a target of 60% value addition, compared to 20-33% for most other exporting industries.

> "For several years now the Indian government has been dreaming about Indian software exports overtaking all other commodity exports in the service sector." (Mukhi & Chellam 1988)

However, all this has left production for the domestic market neglected. The main software policy, in 1986, paid only lip service to its aim 'To promote the integrated development of software in the country for domestic as well as export markets.' (GoI 1986b). Of the policy's 56 measures, 20 addressed software development in general, 30 addressed exports and only 6 were specifically concerned with the domestic market.

No major policy measures have been introduced with the domestic software market solely in mind. General measures, which therefore happen to cover domestic software, include those on entry into the industry, copyright, finance, training and software import. The only ones that relate specifically to the domestic market are those covering government encouragement of R&D, and the floating of local tenders. Those concerned with just the export market include hardware import with export obligations, export incentives, export processing zones, foreign exchange permits, telecommunications, and overseas marketing.

The situation is quite different in most other industries, where there is general agreement that licensing, reservations and import policies have 'restrained development of industrial surpluses for exports' (Parekh 1988; see also Guru 1988). Thus, 'The software industry is virtually the only Indian industry that is primarily export oriented in practice as well as in official policy.' (Sridharan 1989).

3. Indian hardware policy

In chapters 5 and 6, the impact of policy changes on the Indian hardware industry will be considered. This is therefore an appropriate point to consider the chronology of Indian hardware policy[9].

1950s-early 1970s: multinational imports

The first computer was introduced into India in 1956 for use at the Indian *Statistical* Institute. At this point, India had to rely on imports from the multinational corporations (MNCs) since it had no technological capability in hardware. Imports were tightly controlled by government licensing but there was concern over the multinationals' complete domination of the market[10], and the fact that Indian users were given little choice but to lease refurbished, second-hand, out-of-date hardware from them.

From 1966, the government determined to indigenise production and to obtain more recent technology. With this in mind, it focused attention on getting the wholly-owned multinational subsidiaries to dilute their equity. However, their market domination gave the MNCs the bargaining strength to resist.

There was also an attempt to gear up the local public sector company - Electronics Corporation of India Ltd (ECIL) - to produce computers, but this was blocked at first by an argument between the Atomic Energy Commission (which was pro-ECIL) and the Ministry of Defence (which was pro-multinational). Nor did government purchasing policy help. Private companies were allowed no investment allowances and only 10% depreciation on computers, and public sector purchasing was geared towards the intensive use of a small number of large systems. Such large systems could only be produced by multinationals.

[9] Where not otherwise referenced, the material presented here is drawn from Grieco's (1982) history of the Indian computer industry from 1960-80.

[10] Between 1960 and 1972, IBM, ICL and Honeywell accounted for roughly 90% of all sales, with IBM alone responsible for around three-quarters of all computers sold in India (Grieco 1982:26).

1972-1978: public sector production

By 1972, the Atomic Energy Commission had mustered enough support to create an Electronics Commission, which was intended to set policy, and a Department of Electronics, which was intended to implement policy. Combined with the constraint on imports because of foreign exchange shortages, this caused policy to swing strongly towards support for local production by ECIL and against the multinationals or, indeed, any other source of competition to ECIL. A large amount of public funding was invested in ECIL, which began assembling computers in India, and 'the thrust of the policy direction ... was on self-reliance through import substitution.' (GoI 1987e)[11].

At the same time, there was increasing pressure on the multinationals to upgrade their technology, pay for all imports with equivalent exports and, above all, to dilute their equity. ICL agreed to dilute its equity holding down to 40%, but IBM refused and threatened that it would rather quit India, thus leaving the majority of Indian computer installations unsupported and unmaintained. To overcome this problem, the government decided to indigenise maintenance and, in 1976, it set up the Computer Maintenance Corporation which was given a monopoly of servicing all foreign-installed systems in India. The government now felt able to press its case on equity dilution and, in late 1978, IBM decided to leave India rather than fall into line.

The period from 1976-78 can be seen as the peak of government control over the computer industry. The market was segmented in order to protect ECIL's minicomputer production. Imports were tightly controlled with high duties and limited quotas to reduce the dangers of foreign competition; multinational subsidiaries were restricted to mainframe production; and other local producers were denied an industrial entry licence. Government purchasing policy also altered to encourage greater use of minicomputer, rather than mainframe, systems. As a result, ECIL held approximately 50% of the market.

1978-1983/84: private sector competition

The DoE was now caught in a 'pincer movement' of lobbying. While users were complaining that ECIL's computers were obsolete, very costly, and took up to two years to deliver (Grieco 1982, EPW 1984b), a number of private sector electronics companies were complaining that DoE policies were preventing them from entering into computer production.

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11 Sentiments also expressed in GoI (1975b:ii), GoI (1976:9), GoI (1978:93) and Gupta (1982:112).

Early in 1979, as a result of these pressures, the DoE granted licences to 78 private sector firms for the manufacture and sale of small computers. It was still the intention that these would not compete with ECIL's market segment, and production volumes were set very low - only five machines a year for those costing more than Rs.0.3m (c.US$40,000) (Jaikumar & Krishna 1987). However, by listing computers as 'accounting and invoicing machines' the private companies evaded these limits (Shekhar 1987). ECIL also came under pressure because there was an easing of the rules governing hardware imports, and its market share dropped to around 10% by 1980.

These liberalisations were followed in 1981 by a reduction in the duties on electronic components. At the same time, there was a large increase in government purchasing of local computers, particularly for the computerisation of operations in the Life Insurance Corporation (Dataquest 1983b, Shekhar 1987)[12]. These and many other policy changes of the 1980s took their lead from the 1979 Sondhi Committee report on electronics which recommended a relaxation of import and industrial licensing, greater use of foreign collaboration, and a stimulation of demand (GoI 1987e).

1983/84-1987: liberalising supply, boosting demand

In August 1983, there was a loosening of production capacity limits, a reduction in excise duty on computers from 20% to 15%, and a reduction in import duties of 1%-53% on all raw materials, components, printed circuit boards, peripherals and complete systems (Dataquest 1983b). At the same time, the DoE was continuing to invest heavily in training, in research and development, and in ECIL.

The arrival in India of IBM-compatible personal computers (PCs) and of a Prime Minister who laid great emphasis on computers was the signal for a major new policy initiative. This duly arrived in November 1984 as the New Computer Policy (GoI 1984b), which was intended to liberalise and therefore drive down prices (EIU 1986:102). It represented the peak of concerns about consumption, rather than production, of computers.

Import duty on ordinary computers was roughly halved and the most powerful computers were made duty free. Certain types of computer could also be imported by 'actual users' without the need for a government licence; that is, they were placed onto Open General Licence. Import duty on some components was reduced by two-thirds, and on parts for peripherals it fell to only 5%. Bureaucratic procedures for both imports and industrial

12 These computer purchases by government marked a 'major difference in its attitude, which till then had been to tacitly back anti-computerization trade union lobbies.' (Jaikumar & Krishna 1987).

licensing were reduced with the provision of 'single window' clearance. In accompanying statements, indigenisation was stressed far less than had previously been the case.

Industrial licensing for private firms was relaxed, including the removal of all upper limits on production capacity, the confirmation of minimum viable capacity (which excluded many very small producers), and some 'broadbanding' which allowed production flexibility. Large, monopoly companies and those with up to 40% foreign equity were allowed into hardware production, and locational constraints on the siting of production were lifted. Foreign tie-ups were encouraged, with two new technology transfer agreements being announced. Finally, excise duty on computers was removed completely.

However, hardware policy was not completely liberalised. Computers to be imported on Open General Licence had to have at least one megabyte of main memory and 300 megabytes of disk memory, and they were subject to an import duty of 200%. This restricted the likelihood of this import channel being used (Dataquest 1985). Mainframe and super-minicomputer manufacture was reserved for the 'public sector' (in other words, ECIL) for two years; firms with more than 40% foreign equity were only allowed into export-only production; and there was an export obligation to set against all imports by computer firms.

Nevertheless, the liberalisations were substantial and, in June 1986, there was some addition to this, with a reduction to 150% of import duty for OGL computers, and a removal of the public sector monopoly on distributing imported spares (Computers Today 1986d).

At the same time, the demand side of the equation was also addressed, in which the new Prime Minister played on important role.

> "Added to this was the 'computer boys' image that the new government under Rajiv Gandhi had. The Prime Minister, an avid hi-tech buff was keen on modernizing the entire government machinery with the induction of computers. A high profile look was being given to improving the working of the public sector, once again through automation and computerisation. Suddenly, computers were the most talked about thing in the country." (Dataquest 1987b)

The result was the launch of 'a massive programme of computerisation in the public sector, in commercial undertakings as well as in the administrative departments' (Mahalingam 1989). By early 1985, dozens of public sector organisations[13] had announced computerisation plans. By 1987, all these systems were installed, along with

[13] Including some very large ones such as the railways, airlines, banks, schools and coal mines.

others in over 50 central government ministries and departments (Chengappa & Venkatramani 1987). The government thereby 'created a large market for the products of the industry' (Mahalingam 1989) and, throughout the latter half of the 1980s, government and public sector purchasing made up roughly 60% of total sales (Dataquest 1986b, Seshagiri 1988:34, Tandon et al 1990).

Such public displays were deliberately intended 'to promote the creation of demand' in the private sector as a knock-on effect by encouraging private sector managers to consider using computers, and by counteracting conservatism and allaying fears about computers among both managers and workers (Seshagiri 1988:25,37). Such encouragement was combined with an increase to 33% of the depreciation rate allowed on computer equipment.

1987-present: reversing import liberalisations

The relatively liberal level of import policy did not last long for four main reasons:
i. Concern that liberalisation was having some harmful outcomes, such as on the balance of payments (Dataquest 1988b).
ii. The need for government to raise more revenue, particularly from what it now viewed as a healthy industry (Ravirajan & Jaikumar 1987, IDC 1989b).
iii. A backlash from local firms adversely affected by liberalisation (EIU 1986:102, Kumar 1988, IDC 1989b).
iv. Changes in the political economy of the state which reduced the influence of those in favour of liberalisation (Hutnik & Jaikumar 1988).

In 1987, the government increased the export obligations on all new computer manufacturers who wanted to import components (Computers Today 1987e) and, in the 1987/88 budget, raised most import duties (some as far as their 1983 levels) and reimposed excise duty on computers at 10% (Ravirajan & Jaikumar 1987). The only liberalisation was to delicense the import of some peripherals.

The 1988/89 budget imposed a uniform import duty of 98% on all computers and peripherals which, in most cases, represented a small increase. The 1988-91 export-import policy reversed earlier import delicensing of a number of peripherals and computer sub-assemblies, and raised the minimum specification for delicensed computer import (Computers Today 1988a).

The 1989/90 budget further raised import duties on raw materials, components, peripherals and computer industry capital goods by between 20% and 50%, reversed import delicensing of some components, and raised excise duty to nearly 16% (Dataquest

1989e). There were no major changes in either the 1990/91 budget or the 1990-93 export-import policy (Dataquest 1990l, Dataquest 1990q).

The liberalisation reversals were generally limited to the area of trade and some fiscal measures. There were no major changes with regard to foreign investment, which continued to be welcomed, or to government procedure. The public sector corporation ET&T moved into PC assembly in 1989, but at the time of writing it was too early to assess the impact of this.

During this period, there were also signs of a slackening off of government computer purchasing (Shekhar 1988). While the private sector was exceeding its computer usage targets, some areas of the government and public sector - especially education, banking and health - did not fulfill their targets (IDC 1988a). Compounding this, in the 1990/91 budget, investment allowance write-offs for computers were reduced (Dataquest 1990l).

3.1. Indian hardware policy and liberalisation

In very broad terms, one can summarise Indian hardware policy as shown in figure 2.1, with policy in 1990 being something of a compromise between the relative extremes of the 1970s and of 1984.

Figure 2.1

Summary chronology of Indian hardware policy

Structuralism ———————————————————————————— Neo-liberalism

1960s
1970s
1979
1983
1984
1987
1990

However, this very broad picture is not adequate for a full understanding of policy and policy changes, which need to be broken down into the areas of industrial policy noted above.

Inward-looking ... Outward-looking

As regards import duties and quotas, policy was protective in the 1960s and heavily protective throughout the 1970s. There was a gradual liberalisation in the early 1980s, strong liberalisation in 1984, followed by a gradual reversal, so that the situation at the end of the 1980s had reverted to a position similar to that held at the start of the decade[14]. Procedural measures related to hardware trade have been gradually liberalised during the 1980s.

Export incentives are present for the hardware industry, but these have not been regarded as very important because, by contrast with its software counterpart, the Indian hardware industry and policy have focused almost exclusively on the domestic market, at least until the last years of the 1980s.

State ... Market

Government regulatory intervention in the industry increased during much of the 1970s, but then steadily decreased from its peak in the late 1970s, reaching its nadir in 1984 (though the state still retained a large measure of control even then) before increasing very slightly towards the end of the decade. Alongside this change, the state has played a continuous and very important role in its supply-side interventions in skills, R&D, training and investment, and in its demand-side interventions in purchasing policy.

Anti-foreign investment ... Pro-foreign investment

Foreign investment in the Indian computer industry was encouraged in the late 1950s and early 1960s, strongly discouraged during most of the 1970s and early 1980s, and then encouraged again in the latter part of the 1980s.

[14] The following summary of duties (overall import duty unless shown otherwise) indicates how the late '80s position was similar to that in the early '80s.

Dutiable item	1982	1985	1989
Certain components	76 or 158.5%	25%	80%
Peripherals	90%	25% or 60%	98%
Peripheral parts	80%	5%	75%
Computers	184.35%	0% or 76% or 200%	98%
Excise duty	20%	0%	15.75%

Public ownership ... Private ownership

Little role for public sector companies was envisaged in the early days of the computer industry, but this rapidly changed to a desire for the public sector to have the leading role in the 1970s. Since then, the public sector has always been felt to have a role, but there has been no question that the private sector would form the major part of the industry.

Summary

Despite some reversals in import policy, the dominant theme of the past decade in hardware policy has been liberalisation which 'shifted the industry from a regime of government controls and regulations to a liberalised one wherein emphasis is laid on minimum viable capacity, scale economies, easier access to foreign technology, relatively free entry to the private sector (including monopoly houses and FERA companies), with a view to make the industry modern, cost effective and competitive.' (Joseph 1989)[15].

Table 2.1 below summarises the important changes in the models implicit within policy in terms of trade, the balance between consumption and production, and ownership. Overlain on all these changes has been a model that has always assumed a central role for policy and for government interventions in hardware industry development (IDC 1987).

Table 2.1

Implicit models within Indian hardware policy

Period	Dominant model for trade	Dominant model for consumption/production	Dominant model for ownership
1960s	Imports	Consumption	Multinationals
1970s	Import substitution	Production	Public sector
1979-83	Import substitution	Production and consumption	Private sector
1984-87	Imports	Consumption	Private sector
1987-90	Imports and import substitution and some exports	Consumption and production	Private sector and multinationals

15 See also GoI (1987e).

3.2. Comparison to other policies

As with software, the trends of policy change within hardware have broadly followed the trends in overall industrial and technology policy outlined above, though hardware policy has a longer history than that for software. Reliance on multinational imports and then a significant move towards the structuralist model preceded the familiar initial liberalisations of the late 1970s, and substantial liberalisations in the mid-1980s. Post-1984 policy phases are similar to those suggested by Kohli (1989a), with stability in many policy areas after 1987 being seen alongside a clear reversal of earlier liberalisations in the area of import policy.

In comparison to software, many of the changes in hardware policy have taken place further towards the structuralist end of the continuum. While it is probably true (as suggested by Joseph 1989 and Lakha 1990) that hardware policy has been more liberal than that in many other industries, this policy is more representative of the mainstream of Indian industry than software policy. There has been greater emphasis on import substitution, on a controlling role for the state, and on the public sector than has been the case in software.

The only exceptions to this hardware-software contrast have been similarities in policy towards multinationals since 1984, and in import policy between 1984 and 1987. Taken together with the alteration of software policy concerning domestic leasing of imported hardware, these suggest a greater co-ordination between hardware and software policy in the latter half of the 1980s.

In terms of government objectives (see EI&P 1985c), the hardware industry has been almost entirely focused on the domestic market, with the only signs of any genuine concern about exports coming in the last years of the 1980s. This is probably the major point of contrast to software (South 1987). Greater importance has also been attached to import substitution than was the case with software, partly because of the long shadow cast by what many policy makers saw as India's mistreatment by hardware multinationals in the 1960s.

4. Conclusions

This chapter has presented the detail of India's hardware and software policies, which offer some interesting similarities and contrasts. In broad terms, both have shown similar policy change trends to Indian industrial policy as a whole - initial liberalisations in the late 1970s followed by a substantial liberalisation trend in the mid-'80s which faltered after a couple of years.

However, the broad trends hide very different changes within individual policy areas in terms of both the extent of change and its timing. It is therefore argued that, in trying to understand the impact of policy, these individual policy areas must be studied, rather than focusing on policy as a whole.

The substantial liberalisations of software policy place it at the extreme neo-liberal end of the range of Indian industrial policies in terms of trade, state control, foreign investment and public sector role. This makes it an interesting example to study, particularly because it is clear that even in this most-liberalised industry, state interventions have been continuous and pervasive.

However, software policy has only been extreme within the Indian context - it does not conform to the prescriptions of the neo-liberal model except, perhaps, in one way which does set software qualitatively apart from most other Indian industrial sectors. This is the way in which there has been a continuous, almost single-minded orientation of policy (and much of industry) towards export rather than domestic markets.

While both hardware and software policies have a long history, it should be recognised that software policy has only been comprehensive since 1986. Before then, for example, there was no policy on software import. By contrast, hardware policy covering imports, industry entry and other state controls, foreign investment and ownership has been in existence for more than twenty years. Also, unlike software policy, hardware policy has attached greater importance to the domestic market, to import substitution, and to the public sector. This places the hardware industry more into the mainstream of Indian industrial policy than software.

CHAPTER 3

MEASURING INDUSTRIAL DEVELOPMENT

Introduction

The purpose of this chapter is to consider some of the publicly-available, aggregate measures of Indian software industry development. In chapter 1, a number of measures were noted which could be used in order to evaluate the process of policy liberalisation. Many of these, such as 'build-up of local skills', 'dynamic patterns of international division of labour', 'degree of dependence on transnational corporations', 'links to domestic economy', are basically qualitative and have not been reflected in published material.

Of the quantitative measures, the only ones published by government sources cover the level of exports and the number of registered software firms. The only other figures are those published by the Indian computer journal *Dataquest* and its sister organisation, International Data Corporation (India), which cover total industrial output, exports, employment, productivity, and number of active firms.

Neither set of figures can be regarded as accurate. 'As for the regular statistics dished out by the Government of India, I wonder how many of us really believe them' (Mukhi 1989), while 'market research reports, particularly in the software and services industry, need to be treated with a healthy degree of skepticism.' (Schware 1989:5).

Both sets of data rely on company responses to questionnaires, which can be poor. Dataquest/IDC claim to attempt some cross-checking of figures, but those interviewees responsible for gathering statistics pointed out that there were many problems. Companies are usually late in responding and some do not reply at all. Most enter their gross earnings under exports, but some enter net, and some record orders rather than actual earnings. Some companies may also be tempted to artificially inflate the size of their earnings or workforce (though this is more difficult for large companies with audited accounts). Finally, all sources seem to suffer from great confusion between calendar and financial years, often using them interchangeably.

Therefore, the statistics quoted should be seen only as estimates, though they are the best estimates available[1].

It will be argued that, even ignoring their questionable reliability, these measures are a poor representation of the way in which the Indian industry has developed, and that one must look 'behind the figures' using quantitative and qualitative data gathered at the organisational level for a better understanding. Using the latter, it is seen that while growth in exports, employment and size of industry has been substantial, it is not as substantial as it might first appear and that the type of growth may leave this industry vulnerable to external change. It will be argued in this and the following chapter that such a pattern of development cannot simply be explained by the overall trends of policy and policy change.

Before presenting some of the quantitative measures, these will be placed in the perspective of a brief description of the Indian software industry's historical development.

1. History of the Indian software industry

1950s-mid-1970s: close links with hardware

The early history of software development in India, which predates the existence of anything that might be called a software 'industry', is intimately linked to the development of the Indian hardware industry.

Until the mid-1960s, both hardware and software were provided by multinational hardware companies like IBM and ICL. Any software they sold had already been developed by workers outside India. As in the West, however, software development outside the multinationals then began to take place because it became 'increasingly impossible for the computer manufacturers to provide the full range of applications software required to make efficient use of their hardware' (Kaplinsky 1987:10). Such software development was mainly confined to the work of in-house developers writing programs for their own organisations.

During the 1970s, government and academic computer users relied on their own software developers. However, as greater numbers of commercial organisations began using

[1] Unless otherwise specified, all figures listed and all conversions to US dollars are at current, not constant prices. Conversion rates between the Indian rupee and US dollar are given in Appendix A.

computers, they sought to contract software development to outside organisations, such as management consultancies. A domestic market for software services was thereby created.

As India's hardware industry began to grow, indigenous hardware manufacturers began developing an increasing range of operating systems, compilers and applications packages.

The continued difficulty and high cost of obtaining hardware led a number of companies to set themselves up as computer bureaux, using the facilities of a single computer to sell services or computer time to a number of other firms. Typically, the computer used for these purposes was imported and one method of easing the import process was for the firm to agree to undertake software exports.

Mid-1970s-1980: software exports and software products

The first firm to agree to export software in return for permission to import hardware was Tata Consultancy Services in 1974, the year which marks the birth of the Indian software export industry (GoI 1975a:57).

After TCS, a number of other companies which had imported hardware began making some largely half-hearted forays into software export. Many were more interested in leasing the imported hardware to eager domestic users than in exports. Some of those who did export gave up once they had fulfilled their export obligation (Cleetus 1986).

TCS entered into a close relationship with the American hardware company, Burroughs, and this was followed in 1978 by the separation of TCS's Burroughs-oriented workers and contracts into a separate company - Tata Burroughs Ltd - in which Burroughs had a 40% equity holding. TCS and TBL (now Tata Unisys Ltd) were then, and still remain, by far the largest software export companies in India.

At the same time, the data processing (DP) departments of some large companies and the software groups of some Indian hardware manufacturers, began trying to sell their in-house software. They were attempting to sell to the nascent domestic market for software products. As they came to recognise the revenue-earning potential of software, some of these firms made their software units more outward-looking, sometimes hiving them off as a separate company within the overall business group.

The departure of IBM from India in 1978 gave the software industry an added boost, with several of the 1200 ex-IBM employees setting up small software companies, which often began as computer bureaux but then graduated into software development for local clients (Raman 1985, Mehta 1988).

Thus, the number of computer bureaux and software services, software product and software export companies slowly increased.

1980s: software industry growth

Although growth of the industry was slow and erratic, exports particularly began to grow after 1981 because of increasing export awareness and increasing availability of skills in India; because of government action to encourage fulfillment of export obligations; and because of external factors[2]. Small and medium-sized domestic-oriented companies tried to break into exports as the computer bureaux market stagnated and as they found difficulty making other domestic operations profitable.

In the aftermath of the 1984 hardware policy, thousands of PCs came into India and this led to the creation of a large number of software companies, especially small ones, seeking to meet the service and product needs of the new computer owners (Mukhi & Chellam 1988).

Many software exporters had either company or personnel origins in the domestic market - as management consultants; as large company data processing centres; as software developers for domestic hardware installations; as ex-staff of a local hardware or software company (Mehta 1988). However, as the 1980s wore on, there was a tendency in all but a few cases for the domestic side to lose importance, particularly in the case of those companies with multinational links.

Multinational companies started to take a more serious interest in India as a software development source and as a software product market. They set up distribution agreements with local companies, contracted work out to Indian software houses, and entered into equity participation agreements. Others set up wholly-owned software development subsidiaries; the two most successful examples being Texas Instruments (TI) and Citicorp Overseas Software Ltd (COSL).

Towards the end of the decade there was a large increase in local and multinational interest in exports alone. It has been possible for companies to exist and to grow without the need for a domestic-oriented base of skills and resources thanks to the unusual nature of software exports, which can be virtually 'inputless' (see section below on qualitative aspects of software exports).

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2 Discussed in chapter 4 in greater detail.

Summary and conclusions

This brief history suggests the importance of the relationship between software and hardware. The initial build-up of software skills arose in close connection with hardware, while the mid-'80s hardware liberalisations spawned many new software companies. Software development has responded to the various markets that have grown up over the years - in-house, software services, software exports and software products. Software capabilities were initially built up partly through import substitution and wholly through domestic market orientation. But, after a rather haphazard start, interest in software exports has gradually eclipsed the domestic orientation during the 1980s, partly induced through the actions of multinationals. Though the major part of the industry is still locally owned, multinationals have played an important part in this industry's development.

2. Software production

There are no official statistics on overall software production within India, and the coverage of most other figures[3] is unclear - for example, whether they include software exports, re-sale of imported software by local distributors, and software production by hardware companies. Probably the least inaccurate figures are those presented by IDC (1988a:D2), Pawar (1989:E3) and Dataquest (1990w). Even from these, all that can be concluded is that the figures suggest overall software production is growing somewhat slower than exports, and that software exports have made up somewhere between one third and just over one half of overall production.

One thing that is clear is that 'The software industry is yet to take the domestic market seriously' (Bhatnagar 1986:350). The bias towards exports can be seen in the earnings of the top eleven software companies of 1989/90 (Dataquest 1990w). Only two of these earned more than half their revenue from the domestic market, while seven earned less than 20% from the domestic market, of which four had no domestic earnings at all. More than one third of India's export earnings now come from firms which have no domestic market base for software services sales.

Even allowing for the lower value of domestic software products and contracts, such figures are 'a clear reflection of the size of the domestic effort as well as the comparatively *lower focus that it received* from the Indian industry.' (Dataquest 1989l). The lower focus

[3] Such as those from Raman (1985), Dataquest (1987e), Poe (1987), Dataquest (1988i), Mukhi & Chellam (1988) and Dataquest (1989l).

is even found in the available statistics. For, while overall and domestic software production statistics may be rare and rather untrustworthy, there are relatively reliable software export figures from both official and unofficial sources, as discussed in the next section.

3. Software exports

3.1. Overall setting

In India in the 1980s there has been a steady growth of total imports and a more erratic growth of exports. The balance of trade deficit has remained high, while the balance of payments deficit has steadily worsened, with the worst increase (from -US$2.48bn to -US$4.80bn) following the liberalisations of early 1985[4]. Electronics exports have grown from US$53.9m in 1980 to US$506.0m in 1989/90, rising from 0.63% to 3.02% of total exports (DoE annual reports, Dataquest 1990v).

3.2. Gross software export earnings

Figures for gross software export earnings from both the Indian domestic tariff area (DTA) and export processing zones (EPZ) are given in table 3.1 below. Figures are also converted into US dollars to counteract any apparent increase in export earnings that devaluation of the rupee has produced[5].

4 Figures from CEI (1987b), BusinessIndia (1988), Parekh (1988), Das Gupta (1990) and GoI (1990b).

5 These figures may underrepresent true export earnings. Some Indian software companies have set up bogus contracting agencies overseas. Agencies accept contracts from foreign clients and then subcontract to the Indian firm, raking off a percentage of earnings in the process as a fee. Where the agency is bogus, the fee is kept in an overseas account for the use of the Indian software company, but it never appears in their official accounts.

Table 3.1

Gross Indian software export earnings

Year	DTA exports (Rs. m)	EPZ exports (Rs. m)	Total exports (Rs. m)	Total exports (US$m)
1973	0	0	0	
1974	2	0	2	
1975	9	0	9	
1976	20	0	20	
1977	25	0	25	
1978	30	neg	30	
1979	35	neg	35	
1980	30	1	31	4.0
1981	44	15	59	6.8
1982	103	25	128	13.5
1983	170	16	186	18.2
1984	240	51	291	25.3
1985	280	57	337	27.7
1986	420	70	490	38.9
1987	580	118	698	54.1
1988	850	160	1010	72.1
1989	1300	270	1570	98.1

Source: DoE annual reports, CEI (1987a) and Dataquest (1990v).

Market share and growth rates

Throughout the 1980s, the US market has been the major source of export contracts for Indian firms, with a rough average of 65% of India's software exports going to the US (see figures below). India's share of the US custom software and consultancy market can therefore be calculated, as shown in table 3.2.

Table 3.2

US software market and Indian market share

Year	US software market (US$m)	Indian exports to US market (US$m)	Indian share of US market
1981	2455	4.4	0.18%
1982	2762	8.8	0.32%
1983	3107	11.8	0.37%
1984	3495	16.4	0.47%
1985	3944	18.0	0.46%
1986	4693	25.3	0.54%
1987	5585	35.2	0.63%
1988	6646	46.9	0.71%
1989	7909	63.8	0.81%

Source: Coopers and Lybrand/IDC (1986:109), CEI (1987a), Financial Times (1987) and British Embassy-Washington (1988:AnnexJ4). US market figures for some years are based on interpolation or extrapolation.

From these figures, export growth rates can be calculated, as shown in table 3.3.

Table 3.3

Indian software export growth rates

Year	Growth in exports (US$)	Growth in US market share
1981	70%	
1982	99%	78%
1983	35%	16%
1984	39%	27%
1985	9%	-2%
1986	40%	17%
1987	38%	17%
1988	33%	13%
1989	30%	9%

With the estimate for 1989/90 exports being between Rs.1600m and Rs.1750m (IDC 1990, India Today 1990), the industry has not attained the 7th plan export target for that year of Rs.3000m. However, software exports have grown from 7.4% of total electronics exports in 1980 to remain steady at between 20% and 22.5% from 1985 to 1989/90, and from just under 0.05% of all Indian exports in 1980 to just over 0.6% in 1989/90 (DoE annual reports, Dataquest 1990v, IDC 1990).

Export growth rates for this industry are impressive, with Indian software exports growing faster than their main market and thus taking an increasing share of that market. Overall, though, India's market share is still very small and, at a global level, it is even smaller - in 1989, Indian software exports made up less than 0.1% of the world computer services and software market (Kanodia 1990a). Such figures need to be kept in mind to place the Indian software industry's high growth rates in perspective.

Net export earnings

The net flow of foreign exchange into India through software export earnings is less than that represented by the gross figures because these do not take into account the fact that foreign exchange must leave the country to pay for workers' travel and living allowances, and for marketing. From the survey, net income was estimated to be 60% of gross in 1988/89, but figures for this year are rather higher than for previous years because of the growth of multinational subsidiaries, which have a high net:gross ratio, and because more software firms have opened overseas bank accounts in recent years. Based on the survey and figures from the literature (GoI 1977:155, Dataquest 1987a, Mukhi & Chellam 1988), a better average figure for the 1980s is that net income has been 55% of gross.

In one way, this figure slightly underrepresents net earnings because some software developers working overseas save a little from their allowances and bring this back into India as foreign exchange. However, this figure is small compared to the *further* outflow of foreign exchange when multinationals take out their profits and when local companies import hardware and software. Only very patchy figures are available on this outflow, but they suggest something in the region of 20-25% of gross income is flowing out in this way. Taking the average of these figures, true net earnings for the Indian software industry will approximate to those shown in table 3.4.

Table 3.4

Net Indian software export earnings

Year	Net exports (US$m)
1980	1.3
1981	2.2
1982	4.4
1983	5.9
1984	8.2
1985	9.0
1986	12.6
1987	17.6
1988	23.4
1989	31.9

Thus, the total net foreign exchange earnings of the Indian software industry over the 1980s have been somewhere in the region of US$100m. This is a significant sum, but it means that this industry has earned India much less foreign exchange than might be assumed by looking at the gross income figures.

Software Imports

Figures on software imports are few and far between. Software is either imported on Open General Licence, in which case no statistics are kept, or it comes in as part of an overall 'computer system', in which case the element of cost made up by software is unknown. Finally, a very high percentage of software is also pirated, so that there is a large difference between the value of foreign software within India and the amount of foreign exchange that has been paid out for this software. The only available estimates for software imports are given in table 3.5.

Table 3.5

Estimates of Indian software Imports

Year	Estimated imports	Source
1985	Rs.600m (US$49m)	(Tenorio & Field 1986)
1987	Rs.1500m (US$116m)	(Malhotra 1987)
1987	Rs.1700m (US$132m)	(Dataquest 1987e)
1987/88	Rs.180m (US$14m)	(IDC 1988a:D11)
1987/88	Rs.200m (US$15m)	(Mukhi & Chellam 1988)
1987/88	Rs.2500m (US$192m)	(Ministry of Science & Technology official)

Of all these, the Mukhi & Chellam and IDC figures appear out of place, probably because they are based on a survey of business and ignore government purchases[6]. Setting aside these dubious figures, two main points emerge.

Firstly, and not surprisingly, it seems likely that software imports have risen sharply since importation was delicensed in 1986.

Secondly, India probably had a substantial negative balance in trade in software during the late 1980s. In 1987 there was a net foreign exchange outflow from India of something like Rs.1000m (US$78m) in software. Given that software imports since that time have undoubtedly grown, the situation in 1989 is likely to be not much better, despite the large growth in exports, and it may be worse. All interviewees questioned about software trade felt that India was a net importer and, at a 1989 workshop on software exports, the Industrial Adviser to the Directorate General for Trade and Development confirmed this. Looked at in this way, the software trade as a whole does not achieve the main government objective for software of helping to compensate for the large hardware and electronics import bill.

[6] Given that hardware imports stood at around Rs.2000m annually during the years in question, one would expect the software import figure to be at least of the order of Rs.1000m rather than Rs.100m.

Summary and conclusions

Despite doubts about statistics, it seems certain that Indian software exports have grown very strongly since the mid-1970s, the rate of growth being even faster than that of the main export markets, of which India is taking an increasing share. However, India's share of world software trade is still very small, and the net foreign exchange earnings of this industry have been quite limited in comparison to the gross figures.

From the figures presented, one can see no immediate link at this aggregate level between Indian government policy measures - the prime ones being in 1984 and 1986 - and growth in exports. There was a sharp drop in growth rates immediately after 1984, then a sharp rise, followed by some signs of a slow-down in export growth after 1986.

While the link between aggregate liberalisation and export growth is debatable (see also Kabra et al 1987:155), the link between trade liberalisation and import growth is much clearer (EPW 1986, Lucas 1988, Hindu 1989), with the likelihood being that India has suffered a net deficit in software trade and a deficit which may have worsened since the mid-'80s.

3.3. *Qualitative aspects of software exports*

The previous section concerned itself with some of the quantitative shortcomings of India's impressive gross software export figures. The uncertainty of any link between overall policy and export growth reinforces the point made in chapter 2 that an understanding of the impact of policy change cannot be built at this macro level, but requires an investigation of individual policy elements at the organisational level, using more qualitative material. This section looks at the exports from a qualitative angle. It argues that these exports remain poorly diversified in terms of type, market and level of skill.

Custom software work, conversion and package sales

Based on the figures obtained from interviewees, one can estimate a breakdown of export type for 1988/89 as shown in table 3.6[7].

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[7] Figures are similar for 1989/90 (Dataquest 1990w).

Table 3.6

Breakdown of Indian software exports by type

Sales of software packages	1-2%
Digitisation and data entry	<1%
Customised conversion work	20-40%
Custom application building	60-80%

Source: Interviews.

Indian software exports were therefore dominated by export of software services, in the form of custom software work, rather than export of software products, in the form of packages. According to other sources, this has been true throughout the history of the Indian industry (Raman 1985, CEI 1987a:3, Hurtado & Bhatia 1989, Lakha 1990).

Some companies (including COSL, DCM DP, Sonata, Software Research Group, TSG, and Tata Unisys Ltd) have sold a few packages overseas, such as compilers and financial programs. The only major seller has been Wipro Systems Ltd, which has sold several thousand copies of its *Instaplan* project management package. WSL began in 1985 by linking up with a US marketing company, which also helped with the program specifications and design. WSL only received around US$10 (roughly 10%) per copy sold, but the large number sold has enabled it to earn 'between $150,000 and $200,000' (Dataquest 1989o).

Onsite and offshore work

Much of India's export work developing custom software is actually carried out at the client's site overseas ('onsite') rather than offshore in India[8]. Based on the survey figures, an average of 65% of export contracts are carried out wholly at the client site, while 35% contain some offshore elements. This translates into just under 75% of Indian software export development taking place overseas, and only 25% in India[9]. This is even true of work in the export processing zones, which were intended to be bases for offshore work.

There were indications from the survey that the amount of work carried out offshore is increasing somewhat within individual firms. This trend has been particularly noticeable in the multinational subsidiaries, which were the only major exporters to be carrying out more work within India than overseas. Nevertheless, the degree of onsite work has, in general, remained consistently high throughout the decade (see e.g. Cleetus 1984a) and

[8] Thus following a historical pattern of Indian professional and other service workers working overseas (Burki & Swamy 1987, Khan 1988, Sukhatme & Mahadevan 1988).

[9] A figure supported by Kanodia (1990a).

this forms the basis for an *international locational division of labour* within India's software export trade.

Level of skills - time and materials (T&M) and turnkey work

As noted in chapter 1, software development overall is highly skilled, but is usually seen as being broken down into a series of relatively standardised production steps, as shown in figure 3.1.

Figure 3.1

Software production stages

Idea/Problem identified
|
Justification/feasibility
|
Analysis and specification of product requirements
|
[Prototyping]
|
Designing product
|
Coding - writing product
|
Testing
|
Product delivery and installation
|
Maintenance

Actual software development is 'messier' than this simple picture would suggest, with various processes being conducted in parallel and some iteration such that later processes feed back into improved repetition of earlier ones. Nevertheless, for the purposes of this discussion, this model is a close enough approximation to reality; indicating that software development has been fragmented and standardised and, thus, made into a production process (Greenbaum 1976, Kraft 1979).

This process forms the basis for a skill division of labour, particularly because the earlier stages of analysis and design require higher levels of skill and experience, whereas those of coding and testing are relatively less skill-intensive but more labour-intensive:

> "Coding is a relatively simple process ... it does not rely on creativity, organizational understanding, or consultation

with end users. Common business programming representing more than 80% of the world's programming requires comparatively low-level skills" (Schware 1987)

There are two main types of export contract within the Indian software export industry. The first is known as 'time and materials' (T&M) and is generally (though not always) associated with contracts which provide onsite programming services. These services are invoiced on a daily, weekly or monthly basis; payment varying depending on how many staff are used and for how long. In the Indian context, this method of working has come to be known as 'body shopping'[10].

The second type is known as 'turnkey' or as 'fixed price'. In this case, the work to be undertaken is agreed in advance, as is the charge to be made. This type of contract is normally used when Indian companies take responsibility for all stages of software development, from requirements analysis to development and installation. Such contracts frequently involve a large amount of the software development work being carried out offshore, and require a greater level and range of skills than T&M programming services.[11]

As might be expected because of the strong link to onsite and offshore work, the survey results showed the proportion of T&M to *turnkey contracts to be roughly the same as that* for onsite to offshore work. On average, at least 65% of contracts are for time and materials, while less than 35% are fixed price, turnkey contracts[12]. As with offshore work, there are some signs that the proportion of turnkey work is increasing, and at least one multinational subsidiary was using turnkey contracts more than most local firms.

However, in general terms, India's software export trade has been characterised by an *international skill division of labour* such that the majority of software contracts allocate only the less-skilled coding and testing stages to Indian workers. That is to say, Indian workers have far more often been used as programmers rather than as systems analysts or designers. They work to requirements and design specifications set by foreign software developers, as illustrated by the marketing brochure of the US hardware company, Wang:

> "Wang enlists the services of IMC [*US consultancy house*] to pinpoint your needs and requirements - and to design and develop the right software. Then DCL [*Indian software house*]

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[10] Though one ought to distinguish between those companies which provide onsite software development services and those which merely send programmers in response to foreign company requests and so act as glorified employment agencies. Only the latter are true 'body shoppers'.

[11] Normally, 'turnkey' is taken to mean the integration of separate hardware and software into a complete system. However, its use to cover complete software development is so widespread in India that, though not strictly correct, it will be used here.

[12] Even some turnkey projects, such as turnkey conversions, require a lower level of analysis skills than full custom software development projects.

assumes the programming, unit and system testing requirements for your particular design. Finally, IMC takes charge of installation, training and on-going support for the client." (Wang 1988)[13]

Such a division is also seen when packages are developed by Indian firms for the export market (Raman 1985), and is important given the particular design intensity and 'design-level orientation' of software production (Narasimhan 1984:7).

Destination of exports

According to a 1989 workshop on Indian software exports, Indian companies have exported software to over 40 countries, but the figures obtained from the survey support the assertion that 'The overseas market is regionally concentrated too, with a heavy reliance on the US.' (Lakha 1990).

An approximate breakdown of market destinations for 1988/89 exports is given in table 3.7.

Table 3.7

Breakdown of Indian software exports by destination

Destination	Proportion of total exports
US	c.60%
Australia/NZ	c.10%
UK	c.10%
Germany, Holland and France	c.10%
Other	c.10%

Source: Interviews and Widge (1990).

Eastern European countries received as much as half of India's software exports in the mid-1970s, but the proportion declined rapidly after that time and, soon after, the US had established itself as the main export market (GoI 1977:102, 155; GoI 1978:106). Though figures are not certain, it seems possible that there has been some diversification away from the US market since the mid-1980s. Based on the survey and other figures[14], an estimate can be made that, on average throughout the 1980s, the US accounted for roughly 65% of India's software export market.

[13] This division is also described by Correa (1985:32), Dataquest (1988e) and Nash (1988).

[14] CEI (1987a:3), Dataquest (1988g), Mukhi & Chellam (1988) and Hurtado & Bhatia (1989).

Work for collaborator

Survey figures are available on the clients of eight of the top 10 software exporters in 1988/89. Of these, seven undertake the majority of their software exports for a single foreign company with which they are collaborating. On average 70-75% of their exports go to or through one foreign company, underlining the importance of such collaborations to the Indian software export industry.

The degree to which the Indian companies serviced only one client was even greater when those companies were just starting up, with many of them being entirely reliant on their collaborator for software export contracts and only able to attempt diversification after a number of years of single client-dependent growth. The causes and impacts of this situation will be discussed further in chapter 7.

Summary and conclusions

Although there is a degree of variation within the exports of the Indian software industry, these exports are still epitomised by the export of programmers who go to work in the US for a collaborator on a regularly billed basis. There are signs of change. The trend within some individual, established firms (particularly multinational subsidiaries) has been, gradually, towards more offshore, turnkey work and towards diversification away from the US and away from work for a single collaborator. However, with new entrants often relying solely on US-based onsite programming, average change within the industry is much slower and this form of exports has been remarkably persistent (see, for example, Dataquest 1989l).

The figures on net export earnings showed the importance of looking 'behind' gross figures. This qualitative data does the same. Whatever India's export earnings, they have been based largely on relatively low-skill work and their lack of diversification away from custom software services, from onsite work, from programming, from the US, and from a single collaborator leaves India's software exports vulnerable and limited in their ability to grow.

There have been benefits to this form of software export. Because they are carried out onsite, these exports do not require the purchase of hardware or software by the Indian company, or the provision of a technology infrastructure within the country. Because they rely on programming skills, these exports do not require a build-up of higher-level skills in the way that turnkey work would. Because they rely on links with foreign collaborators, these exports do not require such a level of marketing and financing as competition within the open market would.

This helps to explain why Indian firms have been able to move into export with relative ease - they have chosen a path of almost 'inputless' exports which requires only a contact overseas, a little finance, and the names of some local programmers who can be hired if a contract is forthcoming. Such a path can also be followed relatively independent of government policy measures, particularly those on imports, because no imports are needed. Apart from relative ease of entry, such exports also expose Indian workers to foreign market trends, skills, needs and standards[15]. However, there is also a negative picture.

As will be seen in succeeding sections and chapters, this form of export is susceptible to changes in labour migration laws; to automation from new technology; to trends away from contracting out; to alterations in the attitude or financial health of one's collaborator; and to other changes in the macroeconomy. The export of labour services is 'so beset by political and economic uncertainties and so unprotected by international conventions that it can hardly be regarded as the ultimate solution to our domestic market problem.' (Guha 1990b:49).

Onsite working increases the opportunities for a 'brain drain' of talent, while offering programming services can become self-reinforcing with little skill being built up (IDC 1988b, Lakha 1990), so that the higher skills necessary for software process or product innovation remain the preserve of developed countries (Rada 1980a:95). Therefore, 'this type of export arrangement may leave developing countries little room for creating self-reliant capacities in software production' (Schware 1987) and may also leave the Indian industry unable to move to a different form of exports, such as package exports.

Reliance on services limits revenue-earning potential. Exporting one-off custom software services, for example, means that earnings are directly proportional to the number of people working in the industry. By contrast, packages can go on earning for a number of years quite independently of the number of people involved in writing them, thus offering a potential increase in revenue productivity.

Though the government has recognised the current form of exports as a legitimate and even necessary way for companies to break into exports (Dataquest 1989b), it has been concerned about the dangers of continued reliance on onsite programming services that are not sufficiently skill-, design-, technology-, capital-, or marketing-intensive (see, for

[15] See Saldanha (1983).

example, BusinessIndia 1988). As will be discussed in chapters 5 to 8, the government has liberalised imports, encouraged foreign collaborations, and intervened in provision of certain production inputs in an effort to bring about some change in this situation.

4. Software industry companies

Number of firms

The best time series on the number of Indian software firms is that provided by the Department of Electronics on registered software export companies, though this is somewhat less than the actual number of firms which undertake exports, as shown in table 3.8.

Table 3.8

Number of Indian software firms

Year	DoE-registered software export companies	Estimated total no. of software export companies	Estimated total no. of software companies
1981	21		
1982	15		
1983	20	33	
1984	35		
1985	35		
1986	60		271
1987	85		360
1988	90		560
1989		150	

Source: Interviews with government officials, Dataquest (1983a) and Pawar (1989). The figures are in general agreement with those provided by Raman (1985) and GoI (1988c).

Conclusions about these figures need to be tempered because the criteria for DoE export registration have been steadily relaxed over the years. Even so, there has quite clearly been a large increase in the number of companies both undertaking software exports and within the software industry as a whole. Any relationship that may exist between industrial entry and government policy will be discussed in chapter 4.

Concentration

What these figures do not indicate is the high degree of concentration within the industry as a whole (Lakha 1990). Roughly 80% of the firms in 1988/89 had a turnover of less than US$50,000 per annum and most would have been just one- or two-person concerns. By contrast, three firms each earned more than US$10m, representing roughly half of all software production (Pawar 1989:E6).

The situation in software exports is much the same. Table 3.9 shows the percentage of the Indian software export market held by the two largest exporters (Tata Consultancy Services and Tata Unisys Ltd), by those ranked 3rd to 8th, and by the remainder of companies.

Table 3.9

Export market share of large Indian software firms

Year	Tata companies		Next six largest companies		Smaller companies	
	Figures DoE	Figures Survey	Figures DoE	Figures Survey	Figures DoE	Figures Survey
1980	-	63%	-	27%	-	10%
1981	57%	68%	27%	21%	16%	11%
1982	88%	73%	9%	19%	3%	8%
1983	76%	71%	12%	11%	12%	18%
1984	70%	65%	13%	13%	17%	22%
1985	71%	72%	14%	12%	15%	16%
1986	71%	78%	15%	12%	14%	10%
1987	69%	68%	17%	16%	14%	16%
1988	65%	59%	18%	20%	17%	21%
1989/90	-	48%	-	20%	-	32%

Source: DoE officials and interviews. DoE figures exclude export processing zone exports. 1989/90 figures from Dataquest (1990w).

One clear implication from the table is the way in which the two Tata companies have dominated the Indian software export industry throughout the whole of the 1980s, with a market share of around 70% for much of that time, while no other company has managed to gain as much as an 8% share of exports.

The export growth rates (in US$ terms) of the Tata companies for the 1980s are shown in table 3.10.

Table 3.10

Export growth rates for largest Indian software firms

Year	TCS	TUL	TCS and TUL[16] combined
1981/82	59%	31%	45%
1982/83	18%	4%	11%
1983/84	12%	62%	34%
1984/85	11%	37%	25%
1985/86	46%	8%	24%
1986/87	60%	41%	51%
1987/88	24%	19%	22%
1988/89	13%	12%	13%
1989/90	24%	-9%	9%

Source: Interviews, company literature and Dataquest (1990w).

Because of their large market share, the Tata companies' growth rates are an important influence on overall market growth, and the relative slowdown in their growth since the mid-1980s helps to explain why export growth overall has slowed somewhat. Another notable feature is that the growth of Tata Unisys Ltd has been rather more erratic than that of TCS.

The 'middle order' of companies - those that make up the next six largest exporters after the Tatas - have been strongest at the start and end of the decade. However, it was not the same set of companies, as table 3.11 shows.

Table 3.11

Third to eighth largest Indian software exporters

Rank	1980/81	1985/86	1988/89	1989/90
3rd	Computronics	PCS	COSL	COSL
4th	Shaw Wallace	Hinditron	Datamatics	Datamatics
5th	Hinditron	Infosys	TI	TI
6th	Indicos	Datamatics	Infosys	DEIL
7th	CRG	DCM DP	Hinditron	PCS
8th	Systime	COSL	PCS	Mahindra-BT

Source: Interviews, company literature, Dataquest (1983a), Banarjee (1985), Dataquest (1989l) and Dataquest (1990w).

The changing fortunes of this group illustrate some of the benefits and dangers of foreign collaborations and investments. At least five of the original six (all except Indicos, whose

16 This average is weighted according to export revenue.

fate is unknown) found themselves in difficulty when foreign export collaborations went astray through bankruptcy, disinterest, or changed collaboration priorities of the foreign partner. On the other hand, four of the six in 1989/90 (all except Datamatics and PCS) have foreign equity investments, with two - COSL and TI - being *wholly foreign-owned*. These four companies have shown very high growth rates, all moving into the top eight exporters within a year of being set up. In the latter part of the decade, these companies have grown much faster than the Tata companies and faster, too, than export trade overall[17].

The position of the smaller exporters is unclear, but their market share appeared to be strengthening towards the end of the decade. This partly reflects the large number of new companies which have entered into software exports in the latter half of the decade, but also the strength of medium-sized companies (the next 20 or so by rank) which often have foreign or local business group backing. Growth of the very smallest companies has been more erratic because they can be dependent on the gain or loss of a single order, and because finance is hard to come by (Schware 1989:36)[18].

Summary and conclusions

High growth in the number of firms entering software production and software exports is matched by high concentration in which a very few firms dominate dramatically. There are some signs that this dominance was slipping a little towards the end of the 1980s, thanks partly to the growth of medium and medium-large companies with foreign collaborations. For the smallest companies, growth remains difficult.

It is debatable whether this concentration of production is a problem. Schware (1989:78) points out that the main advantage of small firms' presence is an ability to act quickly in order to exploit market niches, but this applies much more to product than to services markets. Other writers have accepted the need for a focus on large firms, at least in exports, because they offer greater certainty of growth (Cooper 1983, Raman 1985, EI&P 1986b, Kumar 1989a:69); they take advantage of scale economies and bargaining strength that small companies do not have (Saldanha 1983, Kumar 1989a:122); and they face fewer entry barriers (Kumar 1989a:122).

This, of course, helps explain why concentration is perpetuated; a point that will be returned to in chapter 4.

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17 See also IDC (1988b:15).

18 It is only thanks to market niches and to low entry barriers for certain types of software production that very small firms are found in software at all (UNIDO Secretariat 1983:9).

5. Employment

There have been hopes that the software industry would be an important source of employment:

> "Software development and data preparation offers the possibility of providing significant employment particularly for mathematically trained scientists and engineers." (GoI 1973:18)

Table 3.12 shows rough estimates[19] for overall employment in software exports; the software industry; the electronics industry (including software); and all Indian industry.

Table 3.12

Software-related and other industrial employment in India

Year	Software[20] exports	Software[21] industry	Electronics industry	All industry
1981			130,000	22,900,000
1982	750			
1983				
1984	1350			
1985		2500		
1986	1700	4000	200,000	25,100,000
1987	2500	6000	230,000	25,400,000
1988	3600	8000	250,000	25,700,000
1989		10000		

Source: Interviews, Computers Today (1986b), CEI (1987a), GoI (1987c), Mukhi & Chellam (1988), GoI (1989a), GoI (1990b) and Lakha (1990). Figures are generally for the end of the year shown.

The figures for software exports indicate the numbers available for export work, not those actually working. Staff are nominally allocated to exports when they are actually doing training or domestic market work, awaiting an appropriate export contract. One company,

19 Figures should be treated with caution. Firms tend to exaggerate the size of their workforce, particularly those on exports, and there is confusion over categorising workers in published statistics.

20 Figures for software exports are based on summing individual firm figures, but they tally with other estimates including: 1983/84 - 1000 (Khanna 1984); 1984 - between 1250 and 1670 (Computers Today 1986c); 1987 - 2500 (Ghosh 1988a); 1987/88 - c.3000 (Mukhi & Chellam 1988).

21 Figures shown are limited in scope. There are probably half as many again working in linked work, such as data processing, systems integration and software development for hardware vendors. In addition, by 1989 there were probably around 40,000 people who had some ability to use software and build small applications (mainly dBase databases) but who were mainly users rather than developers (Interviews, Pawar 1989:E28, Sridharan 1989).

for example, assumed only a 70% utilisation rate on exports for its 'export staff'. This is a process which appears to have become more prevalent in later years.

A better estimate of the actual numbers working on software export can be obtained by summing the figures from the survey for staff overseas (for example, 2100 in 1988; a figure supported by Widge (1990)). If 75% of export work is done overseas, then the total active export workforce at any given time in 1988 was closer to 2800. Previous years' figures will also be correspondingly lower.

Whatever the true figure, software cannot be described as a significant employer in general terms. It employs a few thousand people, against which one may compare a total of nearly three million registered unemployed graduates in 1988 (Pachauri 1990). However, software has become a significant source of jobs for graduates from computer science and related courses.

Growth and turnover

The figures suggest a steady growth in software employment throughout the 1980s. Very roughly, there was a net annual growth of about 200-300 people available for software exports in the first half of the decade. The growth rate steadily increased to more like 1000 annually towards the end of the decade. However, the net figures conceal a larger entrance and exit of staff.

Representatives of most software companies admitted that staff turnover was a major problem for them and, in at least some companies, it was felt to be the major problem.

> "In the world of software exports, since there are no tangible assets being exported, the loss of men or brain-power can be the biggest loss that computer companies face." (Mukhi & Chellam 1988)

Figures given by interviewees suggested that software companies are losing 15-20% of their staff each year[22], but in some companies the losses have been as high as 50% in a single year. Of those leaving Indian software export companies, some leave to work for other Indian companies, because of marriage, or other reasons; but about three-quarters go to work or study overseas and therefore leave the industry permanently or semi-permanently[23].

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[22] Similar to turnover in the Indian computer industry as a whole - 15% (Khanna 1984, Dataquest 1989g), and the UK software industry - 16% (Sweet 1988b).

[23] A pattern seen among many Indian professionals (Burki & Swamy 1987, New Scientist 1990).

Staff join this 'brain drain' mainly because working conditions are better overseas. This is not simply a question of pay levels but of the work environment, the resources available, and the degree to which the software projects are challenging and state-of-the-art[24]. The shortcomings of the domestic market are partly to blame for this (EI&P 1985c). Staff leave particularly when onsite because of constant 'head-hunting' by foreign software agencies (Widge 1990), and because of a sense of exploitation on such contracts if their skills are underused or if they are required to sign financial employment bonds (Interviews, Lakha 1990).

There were some indications from the survey and literature (for example, Bhagnari 1989 and Dataquest 1989k) that loss rates are greatest in larger companies and in those which 'body shop' rather than looking for turnkey work. In terms of the type of worker leaving, the survey produced too little information to offer any definite conclusions, but there are signs that while it was mainly younger staff who went to take postgraduate courses overseas, the largest group to leave for another company (Indian or foreign) consisted of those with a number of years' experience, who have some analysis and design skills. Whatever the proportions, all companies agreed that the loss of the latter was far more damaging to the company than the loss of a junior programmer, who could quite quickly be replaced.

At a rough estimate, then, 15% of Indian software developers working on exports leave their Indian companies every year to work or study overseas, with most of them going to the United States or Australia permanently or semi-permanently[25]. Given that there were roughly 3600 Indian software developers associated with exports in 1988, this suggests that the 'brain drain' in that year was about 550 strong.

Based on these figures, one may estimate, for example, that around 1500 new staff became available for export work between 1987 and 1988 but that there was a net rise of only about 1100. Figures for the overall industry are only available for the latter part of the decade and indicate a net rise of about 2000 people per year, the gross figure being somewhere between 200 and 500 more than this.

Because of staff losses, an even greater number have to be inducted into the industry every year in order to ensure continued growth. For individual firms, the situation can be such that they see themselves as 'running in order to stand still', having to continuously recruit new staff to replace those who are leaving.

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[24] Details from interviews, Burki & Swamy (1987), Dataquest (1989g) and Lakha (1990).
[25] See also Poe (1987), Sachev (1989) and Lakha (1990).

Other effects of turnover

Apart from the need for and cost of extra recruitment, the other effects of staff turnover, particularly the 'brain drain' overseas, are largely negative. As discussed in the next chapter, one principal effect is to hamper the transfer of skills from export work to the domestic market. There is also the loss of money invested in education and training (Abraham 1988)[26].

> "Such losses are even less affordable when the corresponding gains accrue to competitors dominating the markets that the Indian companies seek to further penetrate." (Lakha 1990)

This is a sizeable problem - in 1987, an estimated 50,000 people of Indian origin were developing software outside India (Poe 1987). Most would have been students or other professions rather than software developers when they left India but their skills still benefit competitors and not Indian companies.

Most serious is the loss of staff with several years' experience. It is this level of experience and skills which is in shortest supply in the Indian software industry. The continual losses reinforce the tendency for the industry to have to rely mainly on programming skills, rather than the skills of analysis or project management. For individual firms, staff losses and shortages mean that they place underexperienced staff onto development work; pull staff off unfinished contracts; and/or that they turn down contracts and slow their expansion.

When staff overseas 'skip off' to join another company, this causes friction with the visa-issuing authority which, as discussed elsewhere, has led to problems in obtaining US visas. It also upsets the client, thus placing repeat orders in jeopardy (Tilley 1990).

In theory, not all aspects of staff turnover are negative. The brain drain has been seen as offering a 'shop window' to Indian software talents, offsetting negative images of India, and possibly leading to non-resident Indians (NRIs) within foreign companies being in a position to subcontract work back to India. For example, contracting agencies run by NRIs in the US have been an important source of exports and market information. There are also hopes that there will be a return flow of skilled staff back into India (Abraham 1988) but, as yet, there are few signs of this (Lakha 1990).

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[26] India's total brain drain losses are estimated to have cost the country as much as US$13bn between 1985 and 1990 (Sivakumar 1990).

Qualitative employment details

The average age within most software companies is mid- to late 20s. Almost all staff have first degrees and many, particularly in software exports, have a postgraduate qualification. 5-10% of software developers are female. Women faced particular difficulties because software development often entailed working late, and because onsite programming was seen, as one manager put it, as 'the young, single man's game'. On the other hand, women interviewees felt that software development offered a more relaxed and less discriminatory atmosphere than most other occupations[27].

The figures in table 3.13 compare the breakdown of software development staff in the Indian software industry, indicated by the survey, with the cross section required on an average large foreign turnkey project. Figures for the latter were provided by one of the firms surveyed.

Table 3.13

Breakdown of Indian software workers by type

Worker type	Indian software industry	Average foreign project
Project leaders	9%	14%
Analysts/designers	16%	47%
Programmers	75%	39%

It can be seen that the Indian industry is significantly 'programmer heavy'. It is best suited to providing programming labour, for which there is no shortage of 'raw recruits', while the lack of project managers, analysts and designers makes it difficult for Indian companies to accept turnkey contracts[28]. This is one reason behind the international skill division of labour affecting this industry.

No definitive evidence was available about ways in which the skill profile might or might not be changing. However, there were some signs that it was being maintained because of the steady 'brain drain' of skilled staff (see above), and because there was some tendency for it to be self-reinforcing. Indian company managers see that most of the export work they are offered is for programmers. They therefore feel a reduced incentive to try to raise their workforce skill profile because they see little demand for analysts and the like.

27 Similar findings are reported by Jayanthi & Madhavan (1985).

28 See also Ernest-Jones (1989).

Summary and conclusions

The Indian software industry is not a major employer, but there has been a steady increase in the number of software jobs, mainly for young, male graduates. Employment growth masks a major problem for the industry - that of staff turnover, especially the 'brain drain' of staff overseas which has been encouraged by the use of onsite working. The results of this are almost entirely negative - slower growth; poor skill transfer to the domestic market; loss of training investments; reinforcement of reliance on programming services while foreign competitors benefit; and visa and client difficulties. Especially serious is the loss of analysts and designers, partly reflected in the 'programmer heavy' skill profile of the industry which also reinforces the reliance on programmer services.

6. Productivity

Output per head

Industrial productivity can be measured as overall revenue divided by number of employees to give a figure of output per head. However, given the uncertainty about the exact number of employees to match to a particular set of revenue figures, such calculations give a poor indication of change within the Indian software industry. For example, Dataquest figures (Dataquest 1989l, Dataquest 1990w) indicate a 57% rise in US dollar output per head in exports between 1988/89 and 1989/90; individual figures for the largest firm (TCS) indicate a 35% increase between 1980 and 1988; but the figures above indicate a rise of only 11% for the export industry as a whole between 1982 and 1988.

More can be gleaned through static comparisons of productivity taken from the survey and literature (Dataquest 1989l, Dataquest 1990w). These suggest that:

i. Output per head in software exports is between two and three times that in domestic-oriented software production.

ii. Output per head in the wholly-owned multinational subsidiaries is at the high end of the range.

iii. Output per head in the software industry is less than half that in the hardware industry[29].

iv. Output per head in the Indian software industry is somewhere between one fifth and one half that in the US software industry (US Industrial Outlook 1987, Gaio 1989:214).

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29 This explains why hardware vendors prefer to keep their staff away from software development work unless it can act as a direct 'lever' that will help to sell more hardware.

American industry per capita earnings are high because of the high proportion of packages sold, for which post-development earnings are largely independent of the number of staff involved. Indian domestic-oriented earnings are similarly low because of high competition and low profitability in that market (see chapter 4). The multinational subsidiaries' figure could either be explained by more efficient working methods or by the fact that they have higher staff utilisation rates, with very quick turnround times between contracts.

Software code production

An alternative guide to productivity is the measure of lines of software code produced per person-day. No dynamic measures of this are available, but some static comparison was possible from figures offered within the survey.

When working overseas, Indian software developers achieve productivity levels as high as those of their Western counterparts and sometimes higher by 20-50% (Nash 1988, Tilley 1990, Widge 1990). Figures for development within India suggest that productivity varies quite widely between different companies but that, on average, it may be somewhat less than that achieved in the West. Typical productivity figures were 10-50% less than those of Western companies, with smaller Indian companies performing less well than larger ones[30].

The productivity difference seems to be caused mainly by a lack of resources and of managerial skills. The average Indian company has fewer hardware resources (terminals, PCs, printers, as well as office equipment like photocopiers) per head than the average Western company. Software productivity tools have also taken rather longer to penetrate than in the West. Power cuts are a minor but annoying problem to some firms. In all cases, smaller firms have suffered more than larger ones.

Perhaps more importantly, software project management skills have been found lacking within many Indian companies (Ernest-Jones 1989, Plus 1989, Sridharan 1989). As with resources, this is much less of a problem in many of the larger companies which have built up project management experience and which use standardised scheduling, progress review and quality assurance techniques, so that they do not differ greatly from Western software firms (Cane 1987b, Dataquest 1989d, Mohnot 1989). By contrast, some of the smaller firms admitted 'we just plan as we go along'.

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[30] In some cases, this was partly compensated by the fact that Indian software companies typically work a 45-hour week, while those in the West work a 35- or 37-hour week.

Quality and timeliness

The quality and timeliness of output are also important indicators of industrial performance in software (see Lakha 1990). Again, there are no reliable dynamic measures of these factors but, as with productivity, the quality of work done on onsite contracts 'is of an international standard.' (Tilley 1990)[31]. For work carried out in India, the lack of project management, analysis and design skills already referred to can create difficulties, particularly for smaller firms. Most Indian firms have been able to deliver services or goods no later than any other company (Dataquest 1989d), although some have experienced problems because of staff losses part-way through a contract.

Summary and conclusions

Macro-level measures of productivity are too unreliable to explain much about software industry development. They do suggest that productivity is rising somewhat and that certain firms, markets and industrial sectors are more productive than others. Micro-level productivity, quality and timeliness are as good as that of Western firms when Indians work overseas. Since most Indian export work takes place overseas, this is not an issue that seriously affects the competitiveness of the majority of India's software exports at present. For development within India, the lack of resources and management skills is something of a problem, especially for smaller firms. This restrains firms from taking on more offshore work, and lies behind the poor performance of domestic-oriented software development.

7. Conclusions

The Indian software industry has changed focus fairly rapidly from domestic to export markets. Details about employment, productivity, quality and software production suggest that the domestic market is less attractive and is associated with worse performance than exports.

Assessing the industry through aggregate measures of performance, growth has been impressive in terms of overall production, exports, employment and number of firms. However, a more detailed investigation reveals much lower net earnings; a negative balance of trade in software; major staff losses overseas; and a high degree of concentration.

31 Similar findings are reported by Dataquest (1983a), Nash (1988) and Mitchell (1990).

Large and medium firms have generally performed better than small ones, partly because of a higher level of resources and management skills. Multinationals have played an important role in industrial development. They have brought both associated benefits and costs, though their subsidiaries appear to have been more productive and to do more high-skill, offshore work than other firms in the industry.

Qualitative factors have also been important, with the majority of India's software exports being of relatively low-skill services, carried out onsite for a single US client. This almost 'inputless' pattern of production has been persistent throughout the decade, making the industry vulnerable to external change and causing a number of other negative impacts, including an increased loss of staff overseas which damages the industry both financially and qualitatively.

The thesis question concerns itself with policy change. Software exports, production and employment have all grown throughout the 1980s, as has the number of firms in the industry, but none of these has shown any clear correlation to overall policy change. Meanwhile, industrial concentration, productivity and product quality show no obvious trends of change that could be correlated with any policy change. Only the growth of imports can be linked to liberalisation with any degree of certainty.

Since there is no clear link between the aggregated, quantitative industrial development indicators presented here (except imports) and overall policy change, succeeding chapters will focus on individual policy areas.

This chapter has offered some explanation for observed productivity and quality performance, and for staff losses overseas, but has not addressed itself to the role of policy and other factors in determining software export growth and the observed pattern of exports. Chapter 4 seeks to offer an explanation for these, looking beyond aggregate measures to the nature of export and domestic software markets, and at government attempts to guide industrial production.

CHAPTER 4

UNDERSTANDING SOFTWARE EXPORTS

Introduction

In chapter 2, a bias towards exports rather than the domestic market was seen in government policy and objectives. In chapter 3, this bias was seen manifest in some indicators of industrial production. The purpose of this chapter is to explain the role of policy and other factors in determining the growth of software exports and the pattern of exports outlined in chapter 3.

The policy measures of direct relevance are the liberalisation of industrial entry and production capacity limits, and the provision of export incentives. It will be argued that the former is a necessary but by no means sufficient step towards industrial growth, while the latter is not necessary in the situation of 'super export orientation' which characterises the Indian software industry.

Policy is by no means the only factor to explain the export bias within the Indian software industry. A constrained and weak domestic market is both a cause and effect of this. But constraints are also seen within the export market which help to explain the pattern of exports already described. These constraints need to be addressed; a point returned to in chapters 7 and 8.

1. The market for software exports

Section 2 looks at some of the influences behind entry and expansion in software exports, including the influence of government policy. Before dealing with the issue of why Indian firms enter software exports, it will be useful to understand why Indian firms are able to enter software exports.

1.1. The global software market

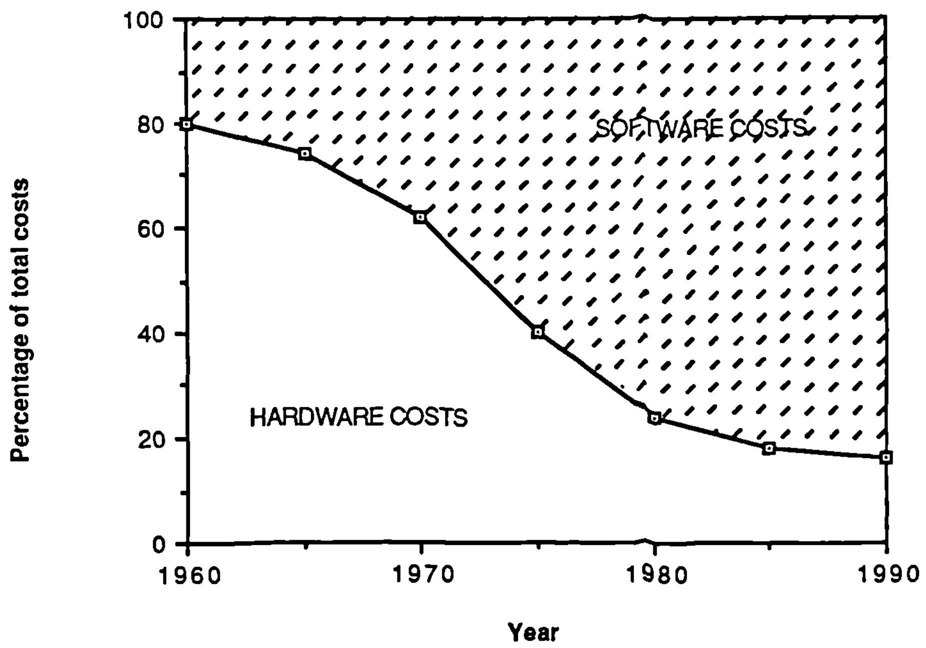
Creation of a global software market

> "In the early years of the computer industry, manufacturers had supplied all the required software 'free' with their machines. But IBM realised in the late 1960s that software could become a golden stream of new revenue, and it started to charge separately for hardware and software. By doing so, it gave birth to the independent software industry, giving other companies a chance to supply programs for IBM computers more efficiently than IBM itself." (Financial Times 1989)[1]

Software therefore became a commodity with a market, and it has continued to grow in relative importance to hardware, as figure 4.1 indicates.

Figure 4.1

Evolution of hardware and software costs in data processing



Source: Gaio (1989:98) adapted from Boehm (1973).

After a modest start, growth in the world software market became almost exponential from the late 1970s onwards, as shown in figure 4.2.

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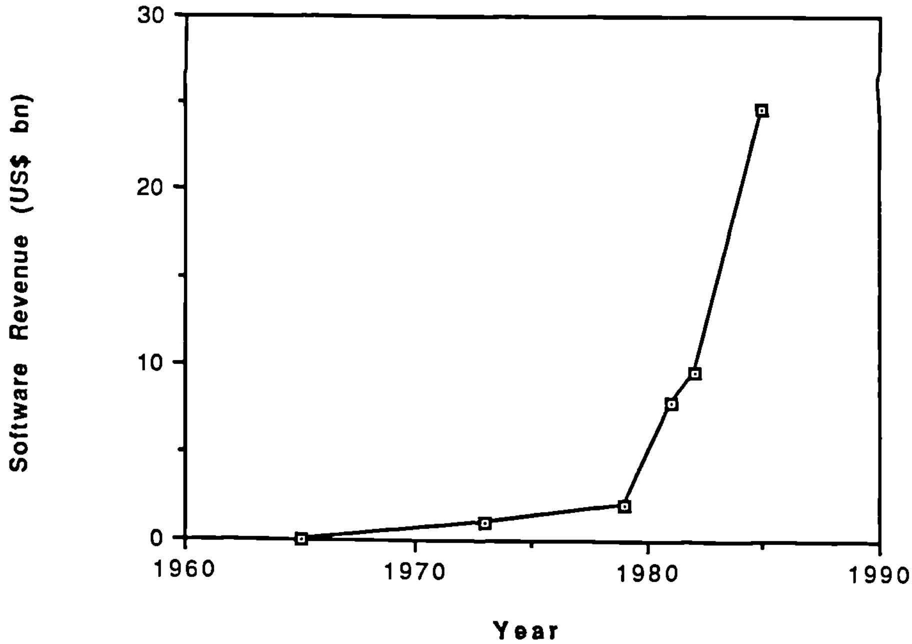
[1] A process also described by UNIDO Secretariat (1983:7-8) and Correa (1985:10-12).

Figure 4.2

Estimated worldwide software revenue



Source: US Dept of Commerce (1984:19, fig.6) quoted in Gaio (1989:138).

It was thus only from the late 1970s onwards that a substantial global software market existed, large enough to justify the efforts and hopes of a potential exporter nation like India. Growth since then has been strong, with the world software and services market being worth US$80bn in 1987 (Mehta 1988).

With the standardisation of job activities, programming languages and hardware environments (Greenbaum 1976, Kraft 1979), the technology and skills within software production became sufficiently stable to allow internationalisation of software services. In a process akin to that explained by product cycle theory (Cline 1987:23-24, Kumar 1989a:10-11) this internationalisation was partly fuelled by the desire to reduce labour costs.

Internationalisation of software services has been further encouraged by the severe software skills shortage in developed countries (Narasimhan 1984:24). In 1989, the gap between supply and demand for software development labour was estimated to be 16,000 in the UK (MacInnes 1989), and growing by 20,000 *annually* in the US (Widge 1990). The consequence is a huge backlog of software projects postponed or taking longer to complete because of lack of personnel to work on them, and a great desire of organisations in these countries to find all possible sources of available skills.

Particularly in the US it has been the desire of both government and companies to make up the skills shortfall by hiring foreign labour, either through contracts or directly by 'poaching' those who come to work on onsite contracts[2].

Future market growth

The world computer software and services market was predicted to continue growing strongly after 1990, rising to around US$340bn (at constant 1985 prices) by 1996 (Coopers & Lybrand/IDC 1986:89, Sridharan 1989, Roy et al 1990). Within this overall growth, sales of software packages were likely to grow fastest (Schware 1989:13, Madden 1990). While substitution of these goods for services could threaten the market for India's software services exports (Srivastava 1985), the market for custom software and consultancy was still likely to grow at more than 10% per year in real terms (Coopers & Lybrand/IDC 1986:32).

While many managers seem to dislike contracting out software development work, all the indications are that there would be an increasing amount of this in future (Coopers & Lybrand/IDC 1986:105, Price Waterhouse 1989:8-11, Price Waterhouse 1990:8-11). Contracting out offers companies the flexibility to cope with fluctuating staff needs or changes in business direction, with freezes on in-house recruitment, and with the skills shortage.

The global skills shortage itself was predicted to continue throughout the 1990s (Schware 1987, Ernest-Jones 1989). However, it was becoming a shortage more of analysts and analyst/programmers than of programmers (Sweet 1988b), and India may face difficulties if it relies mainly on supply of programming staff.

Lastly, Indian companies were fortunate during the 1980s to face relatively little competition from companies in other developing countries. As an increasing number of such countries takes an interest in software exports, such competition is likely to rise. This may well make it more difficult to export from India.

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2 See Burki & Swamy (1987), Sukhatme & Mahadevan (1988), Foremski (1989a) and Widge (1990).

New technology

As discussed in chapter 5, there is growing automation of software development using software tools. This automation will threaten programming jobs and contracting out, particularly in the long term, and cause a greater need for analysts and designers in the medium term. In the short term, however, these impacts are more than compensated by the rising demand for software tool skills. The increasing use of telecommunications technology would also appear to be increasing the opportunities for software exports from India.

India's software tool-related exports have risen rapidly from next to nothing in 1986 to around 20% of all export contracts in 1988. Similarly, by the end of the 1980s, the telecommunications infrastructure had created a path for the export of at least US$10m of software from India (Dataquest 1989l, Dataquest 1990w) - exports which would not have been likely to take place without this infrastructure.

Summary

Since its birth in the late 1960s, the global software market has grown rapidly, with internationalisation of production fuelled by the skills shortage and by job and technological standardisation. It has thus provided a potential market for Indian firms. Future growth of the software services market seems assured for some time to come, but there are longer-term threats from new technology, rising skill requirements, rising competition, and the dislike of outside contracting by some managers. Contractors are also singularly vulnerable during periods of recession (IDC 1988b).

1.2. Market for Indian software exports

Given that there is a world market for software, why should it be that firms within the Indian software industry have been able to obtain a share of that market?

Pay

Low labour costs, of which pay is an important component, have significantly contributed to software export growth. Average basic monthly software salaries in India in mid-1989 are listed in table 4.1[3].

Table 4.1

Average basic monthly software salaries in India

Worker	Salary (Rs./month)	Salary (US$/month)
Entry level, non-computing qualification	1500	90
Entry level, computing qualification	2200	140
Programmer - 1 year experience	3000	190
Programmer - 2 years experience	4000	250
Programmer - 3-4 years experience	4500	280
Analyst/programmer - 5 years experience	5000	310
Systems analyst - 5 years experience	6000	380
Systems analyst - 8 years experience	7000	440
Project manager - variable experience	6-12,000	380-750
Average over whole industry	4500	280

Source: Interviews and Dataquest (1989g).

The figures shown include dearness allowance (an allowance for inflation), but there are various other extra payments which total around 50% of basic pay[4]. Because of these and because of differences in job descriptions, comparison of pay levels with other countries is a little uncertain. However, using figures from UK and US salary surveys[5] one can estimate that salary costs in the UK are four to five times higher than those in India, while those in the US are six to seven times higher. Software salaries are also considerably higher in South-East Asia than in India (Lakha 1990).

Using past salary figures[6], one can estimate that Indian software salaries have been rising roughly 10-15% per year during the 1980s; a rate of increase that is faster than in most Indian industries. The rise can be explained by the high demand and limited supply for

[3] These averages mask the fact that multinational subsidiaries tend to pay more than average; that export-oriented work is usually better paid than domestic-oriented; and that the private sector generally pays more than the public sector (IDC 1988b, Ramaswamy 1989). Software also pays better than most other industries, including hardware (Dataquest 1987d, Dataquest 1989g).

[4] These include annual bonus (related to performance), pension and provident fund contributions, leave travel allowance, medical benefit, and gratuity to long-serving workers. Some firms also subsidise food and transport for their workers. See Seepz (1987:12).

[5] Given in Sweet (1988b), MacInnes (1989), Tilley (1990) and Widge (1990).

[6] Taken from Dataquest (1984b), Raman (1985), Dataquest (1987d) and Ramaswamy (1989).

software labour so that well-financed companies, such as multinational subsidiaries, have driven up wages by constantly offering 'more than the going rate' in order to try to attract the best of India's software professionals and in order to keep hold of existing staff. Annual pay increases have not been greatly dissimilar in the software industries of other countries, so that the wage ratios quoted above have remained broadly stable for a number of years[7].

Charges

Low labour costs would therefore appear to offer a significant competitive advantage to Indian software companies compared to firms in developed countries. However, labour costs are not the only element within overall charges, and overall charges are not at all as competitive as the salary rates, as the tables below indicate.

Tables 4.2 and 4.3 show 1988/89 monthly charges for four types of software developer, comparing rates charged within US end user companies; by US intermediary agencies which hire out Indian and other software labour; by Indian companies working at the client site; and by Indian companies working offshore in India[8].

Table 4.2

Monthly charges made by US software companies (US$)

Worker	US end user	US agency
Junior programmer	$7-8000	$5-6000
2-4 years experience	$8-9000	$6-7000
Analyst	$9-11000	$7-8500
Project manager	$11000+	$8500+

Source: Interviews and company literature.

Table 4.3

Monthly charges made by Indian software companies (US$)

Worker	Onsite	Offshore
Junior programmer	$3000-3500	$1600-2000
2-4 years experience	$3500-4000	$2000-2500
Analyst	$4000-5000	$2500-3200
Project manager	$5000-6000	$3200-4000

Source: Interviews and company literature.

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7 See, for example, 1985 ratios in Kaplinsky (1987:16).

8 Figures are similar to estimates by Ernsberger, Vokey & Jones (1989), Tilley (1990) and Widge (1990).

Very small Indian companies charged as little as US$2500/month for an onsite programmer, while larger companies charged US$500-US$1500 per month more than the figures shown. Similarly, large US agencies charge up to US$12,000 for an experienced programmer, while small agencies run by non-resident Indians charge as little as US$4000, though they also pay less to the Indian subcontractor (Widge 1990).

Despite these variations, Indian software company charges are clearly less than those of US companies. Onsite charges by large Indian companies only undercut US agency rates by about 10-20%, but offshore rates undercut by up to 70%. Even so, this is still greater than the ratio of six or seven to one suggested above from labour costs. Why should this be?

The reason is that overall charges include several elements other than just labour costs. Offshore work must include a figure for hardware overheads and use. Buying and using hardware and software tools in India is roughly twice as costly as it is overseas because of transportation costs, import duties, and high distribution and maintenance costs[9].

Office space in India is costly, with rates in some parts of Bombay being as high or even higher than some Western cities. Communications costs are higher in India than the international average (Darshini 1989b, Kanodia 1990a, Nasscom 1990a), while interest rates in 1989, at between 14% and 18%, were higher than in many other countries. Overseas travel costs are also incurred on most projects and on all marketing visits. Even a modest marketing office overseas will cost US$5000-10,000 per month.

Finally, allowances as well as salaries are paid to staff working overseas. Typical payments for subsistence, rent and local travel are US$1500-2000 per month, and more for senior staff. As in other cases, rates vary and some companies pay as little as US$1200 per month, leaving programmers to live in cramped conditions, using public transport (Widge 1990). However, total earnings for those on US$2000 per month are comparable to the wages of US software developers who, unlike the Indian workers, have to pay tax on their salaries. This tax avoidance is an important element of Indian cost competitiveness for overseas work.

Collecting all these elements together, table 4.4 shows a typical breakdown of monthly charges, based on a software developer with 2-3 years' experience at 1988/89 prices.

[9] Figure based on interviews, Mukhi & Chellam (1988), Kanodia (1990a) and Lakha (1990).

Table 4.4

Breakdown of Indian software company charges (US$/month)

Charge element	Onsite work	Offshore work
Overseas allowance	$750	n.a.
Overseas rent	$750	n.a.
Overseas local travel	$200	n.a.
Overseas travel, insurance and visas	$200	n.a.
Local hardware use	n.a.	$300
Basic Indian salary	$300	$300
Indian salary extras	$150	$150
Administrative and financial overheads[10]	$300	$300
Training overheads	$100	$100
Building and utilities overheads	$150	$150
Miscellaneous overheads	$50	$50
Additional offshore overheads[11]	n.a.	$100
Profit	$550	$550
Total	$3500	$2000

Source: Interviews and company literature.

Wages paid at Indian wage rates make up only 45% of offshore costs and 20% of onsite costs (costs being charges excluding profit). Therefore, although wage rates in India may be low, there is a large contribution to charges from relatively expensive items such as allowances, hardware, office space, marketing, interest rates and communications. This explains why, while Indian software wages may be as little as one-seventh the size of those in the US, Indian software charges are only about half the size of those of the US.

Skills

With its thousands of software developers who are well-educated, English-speaking[12], and technically-proficient, India has been an obvious source for those foreign companies seeking to bridge their demand-supply gap. Indian labour is additionally favoured through its reputation for being flexible and amenable (Widge 1990).

[10] Of administrative, financial and training overheads, roughly US$150 for onsite and US$200 for offshore is taken up in wage costs.

[11] These are the additional administrative, managerial and communications costs which, for onsite work, would be the client's or agency's responsibility.

[12] An important advantage for India compared to many other developing country software industries - see Schware (1989:77).

Summary

India's comparative cost advantage in software services is not as great as simple comparisons of pay levels in different countries would suggest because it is eroded by various other costs. As noted in chapter 3, considerations of productivity and quality do not adversely affect Indian software development onsite, but they will further erode India's advantage for offshore work. Against this, though, must be balanced the much greater cost advantage of having work done offshore.

Overall, India remains a source for cheap software development; an advantage compounded by the availability of skilled labour. This explains why Indian firms have been able to export software.

1.3. Constraints to export diversification and growth

So far, this section has explained why Indian software firms are able to export software. However, a question that arises from chapter 3 is - why does the Indian software industry generally follow a certain pattern of exports, characterised by large companies undertaking onsite programming services for a US collaborator?

In the section below, details are given of some of the constraints faced in the export market which help to explain the persistence of this pattern of exports and which constrain overall growth. All elements of the pattern will be covered except for the collaborations, which are a wider issue and which will be dealt with separately in chapter 7.

Packages

It has already been stated that revenue growth will be locked to the growth in number of software workers unless the Indian software industry can diversify further into development and sales of software packages. Notwithstanding the low cost at which Indian companies can develop such packages, there are serious barriers to entry into this market which are worse than those for custom software (Bhagnari 1990).

Firstly, Indian firms and their developers are not sufficiently familiar with the markets they seek to penetrate, and their distance from those markets makes it hard to keep up with changing needs and standards (O'Connor 1985, Srivastava 1985, Poe 1987, Lakha 1990). As seen below, the Indian domestic market is a poor guide thanks to differences in user needs, work and hardware environments, and the generally low level of innovation.

Secondly, any low cost advantage in development is quickly eroded:

> "Market barriers to new software products have risen significantly over the past two years, with the cost of bringing a product to market becoming a heavy expense. Although software is relatively inexpensive to develop, the costly advertising and marketing effort needed to catch the attention of potential customers has increased dramatically." (Kehoe 1986)

Because of India's lack of reputation as a software package source, high sales would not be expected, making the unit cost of marketing and distribution even higher.

Thirdly, providing support, maintenance and upgrades for a product in a foreign market is either difficult or very costly.

Fourthly, all this assumes success with the product, yet UK experience (IDC 1988b) suggests that only about one in twenty products succeeds, in which case huge investments are required, which are not readily available within India (Srivastava 1985). Even if available, neither government policy nor company attitudes have generally encouraged the high-risk, long-term investments necessary.

Finally, if India did begin successfully exporting packages and therefore threatened US production, pressures for US protectionism would increase, which could lead to trade barriers being created.[13]

Some Indian companies have agreed to undertake custom software work at cut price for a foreign client on the understanding that they will subsequently try to market the developed system as a product for a niche market. Examples include TCS' Casepac and TUL's Easydeal. However, such 'products' often end up being used as marketing or development platforms for further customisation, rather than sold as packages.

The alternative is for the Indian company to collaborate with a foreign firm which will supply the program specifications, marketing, support and finance. The drawback is that the Indian company ends up just supplying programming services in return for a very small share of any revenue (Srivastava 1985).

13 For examples, see Mody (1985) and Computing (1988b). General protectionist trends in developed countries (see Pelkmans 1987 and Thakurta et al 1989) could threaten all types of software export.

International skill and locational divisions of labour

The calculations above indicate that there is a greater cost advantage in having work done offshore rather than onsite, and in hiring analysts rather than programmers. Foreign companies are also likely to be suffering shortages of analysts rather than programmers. Some Indian company interviewees stated that they prefered offshore work because they could use less-skilled staff and train them on-the-job; they could cope more easily if staff members left or if the project started to overrun; their profit margins were generally higher; and they avoided the problems of getting visas[14].

Despite all this pressure in favour of offshore turnkey work, it was noted in chapter 3 that onsite programming services remain the persistent source of most of India's export earnings. The underlying reasons for this are listed below:

i. Credibility. According to interviewees, there is a lack of trust and a perception of risk among clients, who are uncertain of the Indian firm's skills, capabilities and credibility. In order to reduce the risk, many clients choose to retain as much control as they can over production, only contracting out the relatively unproblematic tasks of coding and testing, and having the work carried out onsite.

ii. Hardware. Indian companies do not always have the same computer as their clients. This problem is declining thanks to falling hardware price:performance ratios (Schware 1989:7); to increasing local hardware production; and to greater ease of obtaining imported machines on loan. However, the problem has been circumvented by getting the software developers to go abroad, where they can work directly on the client's machine.

iii. The 'programmer heavy' skill profile, reinforced by staff losses overseas. As noted in chapter 3, this and the lack of resources also reduce offshore productivity and quality in some companies, making onsite work less unattractive.

iv. Continuous client-developer interaction is an essential part of software development (Kopetz 1984:20). In the absence of adequate communications links, interaction will need to be face-to-face, which means the developers going to the client rather than vice versa.

v. As noted in chapter 3, Indian companies benefit from onsite programming because it produces quick revenue for low investment, which suits the lack of risk-taking favoured

[14] Though it was stressed by most interviewees that decisions about skill content and location of contracts were almost entirely client-controlled.

by many Indian industrialists[15]. It also exposes staff to foreign market trends, skills and standards. Finally, many Indian staff want to work overseas and, if denied the opportunity by one company, will simply join another which will send them abroad. This motivates most companies to retain a measure of onsite work.

vi. Policy uncertainty. Software company managers have, at times, been uncertain about the direction of future policy changes; uncertain because of the frequency of policy change; and uncertain because policy is subject to local interpretations and is not always implemented as might be expected in terms of both speed and direction. This has encouraged them to undertake business activities which avoid the bureaucracy and government policy measures as much as possible, and to focus on short-term, low risk, low investment activities[16]. In the context of software exports, this has meant relying on onsite programming services. Certain policy measures - export obligations, foreign exchange restrictions - strengthen this reliance (see below).

Challenges to the international division of labour

In chapter 3, it was noted that individual companies were able to move away from the skill and locational divisions of labour, even though the industry as a whole was not. Some of the factors that have emerged towards the end of the 1980s and have encouraged this change are noted below.

1. 'Trust curve'

Once an Indian company has carried out a few contracts for the same client and has proved itself able to follow a set of instructions or specifications and to deliver on time and to the required quality, then it may be entrusted with a little more of the software development process and/or may be allowed to carry out more of the work offshore.

Indian software companies have therefore tended to move slowly up a 'trust curve' in terms of skills, firstly taking on only the least skilled elements of software production, then also creating the design, and finally accepting responsibility for the entire software development process starting from the client's 'statement of the problem'. Similarly, with location, it becomes increasingly possible that work will be sent offshore.

15 See Kumar (1987) and Ghosh (1988a).
16 See, for example, Ravindra (1987).

Change has not been great, at least in the division of skills, because it has been constrained by the available skill profile, but this does indicate again the importance of trust, credibility and of the client-developer relationship in guiding the division of labour.

2. US visa restrictions

In the late 1980s, the US government issued tougher guidelines on work visas such that visa applications for less-skilled software workers were rejected more often than had previously been the case (Interviews, Bhagnari 1989, Hockenhull 1989, Lakha 1990). This could have made onsite work more difficult to undertake, especially for programmers.

However, the change has been more rhetorical than real, with large numbers of Indian programmers continuing to travel to the US to work. Widge (1990) explains the apparent contradiction as arising from opposing political pressures. Local labour unions in the US want to halt the use of foreign workers and to prevent them taking up residence in the US (see also UNIDO Microelectronics Monitor 1990), and this forces the US government to be seen to be doing something[17]. On the other hand, pressure from US companies ensures that the door remains open because the large skills shortage, and their reliance on foreign workers, means that these companies want the certainty of access that onsite working allows (Foremski 1989a, Foremski 1990, Widge 1990).

Future trends in immigration policy are unclear, and it is one of the weaknesses of a reliance on exports that they remain vulnerable to changes in foreign immigration policies (Kanodia 1990a, Widge 1990). What is more certain is that the changes described pulled a number of Indian companies out of their complacency about onsite work and led them, in 1989/90, to announce plans to increase their offshore working.

3. International telecommunications links

In the late 1980s, use of international telecommunications links by Indian software companies expanded rapidly. Companies were able to access the International Packet Switching Service (IPSS) data transmission network via an electronic 'gateway' in Bombay or use satellite earth stations like those which Texas Instruments has been using since 1987, linking its Bangalore software development office to its headquarters in Houston (Poe 1987). By mid-1990, at least eight software export firms were using such links to

[17] There have been similar complaints in the UK (Akass 1989, Computing 1989, Widge 1990), but no action has been taken by government.

access their client's mainframe computer, based overseas, from terminals based in India, thus overcoming the problem of hardware availability in India[18].

Telecommunications links also enhance the ability of foreign clients and Indian developers to interact on a daily basis; allowing software under development to be sent back and forth and modified according to client wishes (Raghavan 1988, Kanodia 1990a). With greater and improved interaction, there is reduced risk and greater control for foreign clients, which encourages greater trust.

Judging from the 1989 survey, the use of new telecommunications technology has not yet had much impact on the skill division of labour, but it does attack many of the major problems associated with onsite working - client trust, hardware availability, and client-developer interaction - and it appears to be leading to more offshore working within those firms which have access to the technology. By reducing the need for onsite work, such links, though expensive, can also help to save on travel, visa and living allowance costs.

Type of firm

In chapter 3, it was noted that larger firms have dominated software exports thanks to the economies of scale and entry barriers that exist in software production.

> "There are definite economies of scale in this business. The costs of hardware, of training, of marketing (involving frequent and extended foreign travel) are all very high. Again, credibility abroad is very likely to be influenced by the size of the software export company." (Saldanha 1983)

Since Indian software exports are services rather than goods, examples cannot easily be displayed to potential buyers to establish credibility. There is therefore a heavy reliance on reputation, track record, references and the skills and appearance of the marketing team, which all go together to determine the Indian firm's credibility. All these credibility-related factors, which principally hinge on track record and spending on marketing, obviously work to the advantage of larger, longer-established firms[19].

The only short cut occurs if a new firm is set up by an ex-member of one of the large IT companies. In this case the individual can make use of his or her personal contacts and credibility (Raman 1985). Examples include Indusa, IIS and Profitech, which all spun off

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[18] See Dataquest (1989s), Dataquest (1990j), Dataquest (1990k), Dataquest (1990w), Kanodia (1990a) and Tilley (1990).

[19] For example, a few firms had had to invest in export marketing for two or three years before they got their first export order.

from Tata Unisys Ltd in the late '80s, and TSG, which has won exports through the contacts of its managing director, who worked for IBM in the 1970s. However, this does not enable the firms to overcome technology, skills and finance barriers, and it explains their initial reliance on onsite programming services, for which there are few scale economies.

As will become clear in later sections and chapters, there are also biases against small and start-up companies in terms of obtaining foreign collaborations and technology; in dealing with the bureaucracy; and within policy itself. For example, despite the falling real prices of hardware and telecommunications (Ernsberger, Vokey & Jones 1989, Schware 1989:7), these technologies remain beyond the reach of many small Indian firms. Similarly, government-introduced export obligations and foreign exchange permits have aided large firms more than smaller ones (see below).

Within the group of large companies, it is those which are multinational subsidiaries which seem to have performed most successfully (see chapters 3 and 7). One explanation is the speed with which these companies have moved up the 'trust curve' with their owners and have taken on new technology. For example,

> "The limited evidence on the adoption of international data telecommunications systems suggests that the diffusion rates are fastest for the largest multinationals possessing in-house telecommunications skills." (Enderwick 1989:243)[20]

US market

The US market dominates Indian software exports partly because it is by far the world's largest software market, constituting around half of all software sales in the second half of the 1980s (Schware 1989:21), *and partly because 'American information* technology and financial services companies have moved much more quickly than their European counterparts to take advantage of offshore programming.' (Tilley 1990). The US also has more liberal immigration rules for work or residence than most other developed countries (Burki & Swamy 1987).

However, India is also more 'locked-in' to the US market than others because many Indian businesses have links through family members or friends who are US residents; many software developers are US-trained and so understand that market best; and because there is a vast preponderance of US firms in the all-important collaborations which provide so much of India's software export market. Again, this stresses the importance of client-developer relationships.

[20] See also Clairmonte & Cavanagh (1985).

The US-orientation of exports may present a limitation to future growth because US share of the world market is declining and is likely to continue to fall, while the proportionate size and growth of its markets for custom software and contracting out are more limited than in many other nations (Coopers & Lybrand/IDC 1986:89, Price Waterhouse 1989:9). Indian software exporters may therefore have to diversify more into other markets in order to continue expanding.

Summary

> "More generally, developing countries' prospects in establishing an export-oriented software industry, are hampered by a number of technological, financial and marketing constraints." (Correa 1985:30)

It is mainly constraints and barriers within software production and within the global software market that have led to the persistence of India's pattern of software exports which are low-skill, low-technology, low-investment, and low-return relative to other options. The barriers include - access to finance, access to new technology, credibility and other elements of the client-developer relationship, marketing and marketing costs, level of available skills and training, the threat of protectionism, managerial attitudes, and a weak domestic market. Most of these not only constrain diversification but also the entry of new firms and the growth of software exports in general.

The only area in which change seems likely is in the growth of offshore working, at least within certain individual firms, thanks to the combination of new telecommunication links and the threat of increasingly restrictive visa policies in the US (Nasscom 1990c). Greater development of credibility as client-developer relationships build, and greater availability of suitable hardware within India have also helped.

Uncertainty about policy making and implementation has affected the pattern of exports as much as specific policy measures, though some of the latter have also reinforced onsite programming services. Where policy has had a greater impact is in the way it has or has not addressed the constraints already described. The government has recognised two routes by which constraints can be overcome - by multinationals and by government itself. These two approaches are not mutually exclusive and are discussed, respectively, in chapters 7 and 8, except for technological constraints which are covered by chapters 5 and 6.

Neo-liberal models have tended to focus heavily on price factors (Foley 1989:17), but the evidence here is that in the real markets, far more than just price has to be taken into account[21]. India's low labour costs have been an important factor in its software export trade (see Dataquest 1983a, Tilley 1990), but they are by no means the only important factor.

> "Cost savings are the least important benefit ... There is no point in having a cost saving if you don't get the system you want." (Nash 1988)
>
> "Software is a high-risk business and is not dependent on costs alone. Time is important. Quality is important. Credibility is important." (Lakha 1990)[22]

If labour and related costs were of overriding importance, one would expect both the locational and skill divisions of labour in software services exports to disappear because of the added cost advantages. Similarly, with their low production costs, Indian companies ought to be global competitors in the software package market. The fact that labour divisions persist and that India exports very few packages shows that factors such as productivity, quality, timeliness, client-developer relationships, marketing, availability of skills and technology, and other factors have outweighed labour costs in shaping the nature of exports.

2. Causes and impacts of export orientation

2.1. Entry into software exports

This section studies why it is that Indian companies choose to set up software export operations, and it assesses the importance of policy in such decisions.

The data in chapter 3 suggested that there had been a general increase in the number of software export operators over time. More accurate information on the timing of entry into software exports was gathered from the survey and from secondary sources. Year of entry into software exports of 40 major software exporters is shown in figure 4.3[23].

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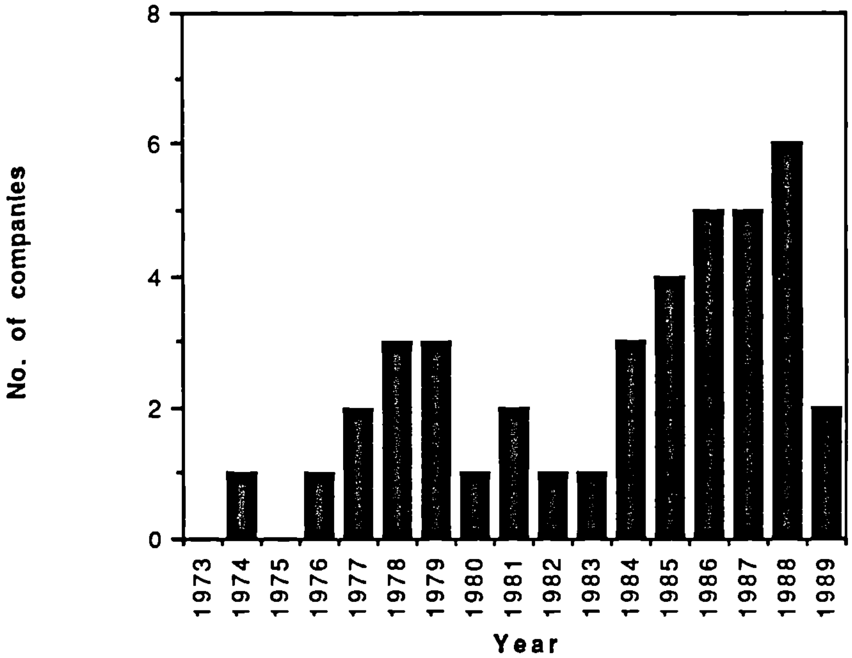
[21] A point also made by Elson (1988), Lucas (1988), Nayyar (1988), Wield & Rhodes (1988) and Foley (1989:22).

[22] See also Elsoftex (1988).

[23] Statistics for 1989 are an underestimate because complete data on new entrants could not yet be obtained at the time of writing. There is also a bias in these figures towards those companies which survive in exports - as DoE registration figures indicate, a number of software export companies were set up in the early 1980s, but only in order to import and then lease out hardware, not to export software.

Figure 4.3

First year of software export operations for main Indian software export firms



Source: Interviews, Dataquest (1984a), Dataquest (1987e), Dataquest (1989l) and Dataquest (1990w).

The figures suggest that entries into the exports have increased over time, and that they have taken place more in the late 1970s and second half of the 1980s than in the early 1980s. There were important policies issued by government in 1976, 1984 and 1986 that aimed to encourage software exports, while the policy during the early part of the 1980s was one of tightly controlling, if not discouraging, hardware import for software export. This suggests that policy may have had some role to play in company decisions about entry into software exports.

Further details were obtained from the survey about reasons for entry into exports. The main theme running through almost all reasons given was the contrast between the domestic and the export markets. The most common reason was the perception that exports offered a huge market and the possibility of high earnings. Exporting was also undertaken for other benefits that the domestic market could not offer so well, such as up-to-date technology awareness and skills; staff motivation; and good company image and track record.

Firms were also keen to move into software because it formed a natural corollary to their existing work, such as management consultancy or hardware sales, and because this was the area in which those setting up the company were most skilled.

Compared to perceived market and company/staff background, policy was reported to have had an impact more through its overall effect on perceptions than through any individual policy measures[24]. As one company director commented:

> "It is not a good analogy, but policy was like the straw that broke our camel's back. We had been aware for some time that we might earn money from exports and then policy came along, government and press was talking about software and other companies seemed to be following this path, so we decided to go that way also."

So perceptions about competitors who were gainfully entering the market and the publicity given by government and government policies to the export market have contributed, and a number of company decisions seemed to be based on managerial perceptions rather than market analysis[25].

The rate of change of policy has also had an effect. 'Companies prefer stable rules to unstable ones even if slightly more unfavourable' (IDC 1988b), and many interviewees reported that investment decisions had been postponed because of uncertainty over the rate and direction of policy change (see also Ravindra 1987). The relatively greater degree of policy stability since 1986[26] may have encouraged more industrial entry and expansion.

By comparison with its indirect role, policy has played only a limited role in directly encouraging exports. Several organisations imported hardware under the special government scheme, and a few of these were motivated to undertake software exports because of the system of export obligations.

Industrial licensing

The absence of industrial licensing and production capacity control had come to be taken for granted by most software companies. Some interviewees indicated that they had been somewhat discouraged by the need for government licences prior to 1984, while the

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24 In his study of export policy in Turkey, Milanovic (1986:66,73-74) also stresses the central importance of the perception of policy, rather than policy *per se*, in guiding managers' decisions.

25 This may help to explain the relatively poor performance of some software companies (Computronics, DCM DP, ORG, Shaw Wallace, Sonata, TI&M, WSL) created by large business groups, which perceived software as a 'get rich quick' diversification, without realising the need for investment in skills and equipment. See also UNIDO Secretariat (1983:9) and Dataquest (1988a).

26 Also seen in other industries (Jha 1987:35, Wadhya 1988).

removal of control had enabled them to save staff time and costs spent in related administrative work. The absence of controls on capacity production and entry of very large (MRTP) companies into software has also allowed the presence in the industry of large companies which can benefit from the scale economies, marketing, investment and bargaining strength which, as noted in chapter 3, are important in software.

Liberalisation of industrial entry and production capacity licensing has been more pronounced in hardware than in software, and the impact has been easier to assess. In the mid-1970s, licensing allowed the public sector company ECIL to remain uncompetitive, while production capacity limits and reservations for small-scale industries allowed an uncompetitively small scale of production (EPW 1984a) which might have remained had computer companies not managed to work round the rules in the late 1970s. Such controls on licensing and reservations also helped to maintain 'technological dependence and stagnation' (Swaminathan 1988b; see also Lall 1984b).

There was a large rise in the number of hardware companies once licensing was liberalised (Chengappa & Venkatramani 1987, Jaikumar & Krishna 1987). This may have encouraged competition between firms which, combined with removal of capacity constraints, helped prices to fall, technology to be updated and the industry to grow (Verghese 1986, Hindu 1989, Joseph 1989, Malhotra 1989a). As in software, removal of capacity constraints has been important because of the need for the scale economies, investment and marketing strengths that large producers offer (Hutnik 1988a, Shekhar 1988).

There is other evidence from the literature that industrial licensing failed to control industrial concentration or to develop small-scale industry (Patel 1987:167, Lucas 1988, Paranjape 1988); led to uneconomic scales of production (Patel 1987:167, Lucas 1988); stifled growth (GoI 1987e, Hussain 1987:369); and led to delays and corruption (Weiss 1988:311). Many writers argue the need for liberalisation of industrial and production capacity controls (EPW 1984a, GoI 1987e, Hussain 1987:369, Lucas 1988, Paranjape 1988, Singh & Ghosh 1988), particularly in the face of a rising pace of change and increasing complexity in industrial production (Ghosh 1987).

Summary

Problems in the domestic market and, to a lesser extent, company and staff background appear to be the main causes of entry into software exports[27], supported by observation of competitors' behaviour.

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27 See also Milanovic (1986:66).

Policy has played a limited though complementary role in influencing entry (and expansion) into software exports. It has influenced decisions more through the fact of its presence as much as its content, and through its stability as much as the direction of change. Only the existence of export obligations has had any noticeable direct impact.

Evidence on industrial entry and production capacity controls from the software industry is limited, but seems to support the findings in hardware and other industries that liberalisation of these controls has brought greater competitiveness and technological updating. In software, at least, the liberalisation of licensing cannot be seen as a cause of growth - it has removed a disincentive and constraint rather than offering a positive incentive. In this light, this liberalisation may be seen as a necessary step to industrial growth but one which is by no means sufficient.

2.2. The domestic market for software

Software managers stated that they perceived shortcomings in the domestic market which encourage them to move into exports. The following section investigates whether such shortcomings can be observed and what they and their causes might be.

Competition in the package market

Software piracy is rife within India, particularly affecting the market for imported microcomputer packages (Khanna 1988a, Mukhi & Chellam 1988, Polavarapu 1989e). Government legislation on software copyright, introduced in 1984, has yet to lead to any prosecutions, but there are signs that piracy has decreased with an estimate that 98% of packages were pirated in 1986, 90% in 1987/88, and 80% in 1989 (Interviews, Ghosh 1988a, Tandon et al 1990). Government legislation and pressure are not solely responsible - user awareness of the need for support and updates has helped, as has the arrival of software viruses (see, for example, Dataquest 1990m).

Piracy has been beneficial in supporting the rapid expansion of computer use, in forming a wide base of software skills, and in saving greatly on foreign exchange. However, it has also harmed local producers. With pirated versions of globally-standard software often costing less than Rs.500 (c.US$35), local producers are forced to reduce the price of their products to Rs.2000 or even Rs.1000. Piracy therefore reduces the revenues and market size for local package production[28], and 'an ability to control software piracy will determine the growth of the software industry in the coming years' (Bhatnagar 1986:351)[29].

Domestic packages also face competition from legally imported software, which further eats into the market for local producers. In these circumstances, a 'successful' local package is one that sells a few hundred copies (Interviews, Mehta 1988). Revenues are cut further because many clients sold a software 'package' will insist that it is then customised to their particular needs for little or no extra charge (Ghosh 1988b).

Competition in custom software

A typical medium-sized custom software company faces strong competition from four main sources:

i. Moonlighters. Software developers in large organisations (often public sector) with access to a computer may have spare time, which they use to work for outside companies. Since they already receive a salary, they charge very little.
ii. One/two person companies. These have low overheads, often because they are an offshoot of an existing family company. Having no 'track record', they rely solely on low price to win work.
iii. In-house development. Disenchantment with poor performance by outside contractors has led many Indian organisations to prefer to develop work in-house (see IDC 1988a:D9, Pawar 1989:E12).
iv. Large software houses. Such firms will often charge very little if they feel they can use a domestic project as a training ground for staff, or as a 'foot in the door' for later, larger contracts.

This level of competition tends to force down charges for custom software work. Such charges ranged between US$300 and US$1000 per month in 1988/89 for a typical medium-sized company, allowing much lower revenue and profit per worker than export work.

28 While roughly 50% of US software industry revenues come from packages, the figure is estimated to be only 15-30% in India by Mehta (1988), IDC (1988a:D9) and Pawar (1989:E9), and only 4% by IDC (1990).
29 There is evidence for this from India (Ghosh 1988b), Brazil (Gaio 1989) and China (Baark 1990).

Market size, profitability and growth

As well as seeing competition eat into their markets, all software companies operating domestically complained of what they saw to be a 'something for nothing' attitude among clients (see also Lal 1990). Individual users will rarely pay for software (Mukhi & Chellam 1988), and even in 1989, only 35% of companies using computer systems had made budget allocations for software (Pawar 1989:E21), leaving most demand confined to large government, public- and private-sector organisations. Thus, while the global ratio of software:hardware spending is around 70:30, in India it is more like 30:70 (Pawar 1989:E3, Lakha 1990).

It has already been noted that revenue per worker in the domestic market is two to three times lower than that for exports, and profits have been similarly lower (IDC 1988a:B26)[30]. Profit and loss figures for only seven firms could be confirmed in the survey but, of these, the three that made a loss earned an average of 88% of turnover from the domestic market, while the four in profit earned 68% of turnover from exports.

It is not surprising that many domestic-oriented firms have been unable to grow:

> "It is not a profit making field. ... In terms of operations, it is represented by operators with minuscule margins, and who in their mad race to grow are running to stand still." (Polavarapu 1989e)

Domestic products and skills

Because of low sales, low prices and high marketing costs (Pawar 1989:E23), it is very hard for local producers to justify investing in package development. As a result, those who develop packages may try to cut corners by releasing poorly-developed, poorly-supported products (Ghosh 1988b). Reliability, documentation and user-friendliness of most Indian products also lags global standards (Guru 1988, Plus 1989, Tandon 1990). This only serves to reinforce the popularity of imported products (Pawar 1989:E25, Polavarapu 1989e) and further constrain the market for local packages.

Because of poor domestic revenues, the best software developers are put onto export work, or they choose to move to exports because of its added attractions (Muralidharan 1988). As a result, according to both developers and clients, software developers working in the Indian domestic market are less mindful of addressing client needs than those who have worked in exports. Project management is rather loose and projects themselves tend to be

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30 This is the opposite to the situation in most industries (Lall 1987:27).

fairly small. As will be discussed in later chapters, the only exceptions have occurred through government training or commissioning of large projects. Overall, software skills in the domestic market have not been well developed.

Summary

Domestic software markets are of fundamental importance to software industry growth (Narasimhan 1984:47,52) but, because of intense competition from pirated products, from imports, and between software houses, the Indian domestic software market has been characterised by low revenue, profits and growth. Piracy and low user spending also constrain the overall size of the market. The resultant relatively poor standard of domestically-produced products and custom software work only serves to reinforce these market weaknesses, trapping the market in a cycle of constraint.

Government action on copyright legislation (like the liberalisation of licensing) has been a positive and necessary, but not sufficient step to address these problems. Government has boosted the consumption of software by fuelling a hardware boom in the mid-1980s, but it has been less successful in boosting the legal demand for local production, as discussed in chapter 8. The fact that government objectives and policy measures have been largely concerned with promoting exports, as noted in chapter 2, only serves to reinforce the deficiencies of the domestic market.

It is therefore not surprising that so many initially domestic-oriented companies have diversified into exports[31], nor that many foreign software services companies have ignored it. Foreign hardware companies have shown an interest in domestic software development only as a method for increasing sales of their computers. Foreign software product companies have set up local distribution agreements, but only where these involve low risk and low investment (see chapter 7 for further details).

2.3. Export incentives

One specific set of policy measures which aimed directly to promote software exports has been export incentives. The provision of such incentives is consistent with the outward-looking approach, which intends that they should compensate for an inherent bias in favour of the domestic market and against exports. India's export incentives are intended to

[31] At least eleven surveyed companies had done this, including four of the top 15 exporters of 1989/90, while several others had 'diversified' immediately to exports alone because of the shortcomings of the domestic market.

compensate for the high cost of inputs that protectionism creates and to provide a further positive incentive to exports (Nayyar 1988). The importance and impact of these incentives - both software-specific and general - is assessed below.

Software-specific export incentives

The incentives are described as they stood in 1989. Changes to these measures over time are described in chapter 2.

i. Cash compensatory support. This is a direct subsidy to exports paid by government at the rate of 10% of the net foreign exchange earned on any software export contract for ordinary exporters, and half that for those in export processing zones. Although payment was simplified in 1990[32], past uncertainties over this subsidy[33] led most companies surveyed to state that they did not take it into account when calculating contract prices and merely regarded it as a bonus if and when it did arrive. In any case, since 1987 it has been partly offset by the 15% tax on foreign exchange outgoings.

ii. Tax exemption. During much of the 1980s, 50% of software export profits were tax-exempt. Although this was an incentive, it must be seen in the context that profits for all manufactured exports and even some services were wholly tax-exempt (Computers Today 1988d)[34].

iii. Export credit, guarantees and insurance. Pre- and post-shipment credit was available through the ExIm Bank, and export credit *guarantees through the Export Credit Guarantee* Corporation (ExIm Bank 1989b). These have proven to be useful sources of finance for software companies. Insurance against malpractice or lapses was available through the General Insurance Corporation.

iv. Foreign exchange permits. Software companies were given an annual 'blanket' foreign exchange permit equivalent to 30% of the previous year's net foreign exchange earnings[35]. This could be spent on new hardware, software, marketing and travel. In the context of India's general industrial policy and foreign exchange controls, the permit represented an incentive. Companies could also negotiate with the Reserve Bank of India (RBI) for larger releases of foreign exchange, and could use separate tranches to import foreign software

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32 See Dataquest (1990n) and GoI (1990b:126).

33 See, for example, Kanodia (1989) and Dataquest (1990f).

34 Late in 1990, software export profits were also ruled wholly tax-exempt (Dataquest 1990y).

35 These earnings are calculated by subtracting spending on marketing, travel and allowances plus annual export obligation from the gross foreign exchange earned by all contracts registered with the Reserve Bank of India (RBI). Given most firms' rapid growth, this permit often represented only 10-15% of the current year's gross income.

for distribution; to import hardware with a high export obligation; or for individual travel.

Nevertheless, for most companies, the permit also represented a regulation and a restriction. The largest companies have permits as high as US$1m, but medium-sized firms typically received between US$10-100,000, and smaller firms much less. These latter firms complained that they were constrained by their lack of foreign exchange, particularly in regard to marketing and distribution overseas (see, for example, Kanodia 1989). It is felt that this reinforces the reliance on onsite programming services and acts as a barrier to new market entrants and to product exports (see, for example, Dataquest 1989o).

v. Export obligations. With the foreign exchange permit, previous exports allow a subsequent spending of foreign exchange. Under the export obligation scheme, spending of foreign exchange is allowed on the promise of subsequent exports. Indian software exporters who agree to achieve a certain level of exports over a four-year period are allowed to import computers and related items more readily, more quickly, and at a lower rate of duty than ordinary importers. They have to lodge a financial bond backed by a bank guarantee, and there is a promise of heavy payment penalties for non-achievement of the required exports.

This scheme has therefore been a mixture of incentive and regulation. It has pushed some firms into exporting, particularly those which imported the hardware for domestic market purposes. However, smaller companies have been put off importing hardware because of the high obligations, which have again reinforced reliance on onsite programming services[36] or on use of local hardware. Only for the largest software companies has the scheme been seen as an incentive. Knowing they will achieve a high level of exports, they have used the scheme merely as a way to pay less import duty on their computers.

General export incentives

1. Devaluation

The government has allowed a steady depreciation of the rupee against most major currencies during the 1980s. For example, the value fell from Rs.7.75 to the dollar in 1980 to Rs.17.5 in 1990, a devaluation of around 125%. Naturally, this will have improved the relative price competitiveness of Indian software exports though, as seen

[36] Chandmal (1987) compares their situation to that of a young cricketer who is told that he can buy a foreign bat, but will be severely punished if he does not score a century in his next test match.

above, at least half the cost of onsite work is payable in foreign currency and therefore unaffected by such changes. Given the already large cost advantage that India enjoys in software exports, devaluation is not likely to have made that substantial a difference to export performance.

Nayyar (1988) makes a similar conclusion in relation to the overall Indian economy:

> "Clearly, the depreciation of the rupee in real terms was a contributory factor insofar as it improved the price competitiveness or the relative profitability of exports but, by itself, it cannot constitute an explanation for export performance which was influenced by a wide range of external and internal factors."

Bagchi (1990) points out that, in combination with import liberalisation and rising import-intensity of production, devaluation can lead to rising production costs and will also force higher debt servicing charges. He argues that devaluation is too much of a 'blunt instrument' and needs to be replaced by a more selective approach.

2. Export processing zones

Since 1965, India has been operating export processing zones (EPZs) which are cut off from the domestic tariff area (DTA). The intention is that these should provide incentives not available within the domestic area in order to boost export earnings (Kumar 1989a:foreword). Since 1981, most of these incentives have also applied to export-oriented units (EOUs). These units export all their output, but lie outside the boundaries of the normal EPZs and so lose the benefits of centralised administration and infrastructure.

The principal incentives available to EPZ firms are fast, duty-free import and export; a 'single window' for all bureaucratic dealings; exemptions and subsidies on sales and excise tax, rent, power and water; a five-year tax holiday; and permission for wholly-owned foreign firms which can freely repatriate profits (Seepz 1988, Nabhi 1989). All this has been at considerable cost to the Indian government in terms of customs duty and other taxes foregone, and spending on subsidies, cash compensatory support, and infrastructure.

In overall terms, performance has been quite good. By 1989, there were over 30 software companies operating in EPZs or EOUs[37], and they contributed just over 20% of all software exports from India. By far the most important zone has been the Santa Cruz Electronics Export Processing Zone (Seepz) in Bombay.

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[37] See Seepz (1988), Kalra (1989b) and Kapur (1990).

For most local firms, EPZ and DTA exports have been largely substitutable. In their survey responses, managers of such firms - most of which were already exporting before they located part of their operation in the EPZ - stated that they had been attracted to Seepz because it provided large, well-connected office space at very low rent in India's commercial capital[38]; a tax holiday; and less bureaucratic hassle. For them, the presence of zones like Seepz had not been an incentive to create new exports, but more a way of providing additional financial returns on existing exports and investment (though, of course, this will encourage further exports).

By contrast, eleven foreign multinationals (MNCs) had directly invested about US$15m in EPZ and EOU software firms by 1990[39], with further indirect investment by way of staff training and donation or loan of hardware. Evidence from interviews suggested that this had taken place because of the EPZ policy measures, including the ability of multinationals to wholly own and control their subsidiary; the freedom to export and import; the avoidance of lengthy bureaucratic procedures; and the use of the infrastructure already present. It was stated that these investments probably would not have taken place but for the policy incentives, and that subsequent exports were therefore not substitutable for exports that would otherwise have occurred in the domestic area.

As was the case with devaluation, the export incentives provided within EPZs are not attuned to the particular circumstances that affect software production, but have also been applied as a 'blunt instrument'. Local software firms have shown themselves perfectly willing and able to export from the domestic tariff area without the need for any extra incentives. For them, any help that the zones may have offered has been largely incidental, through the provision of good infrastructure and additional profits that can be ploughed back into better marketing, and there are clearly more direct ways in which such infrastructural and marketing assistance to exports could have been targetted.

The zones have attracted additional foreign capital and thereby created additional foreign exchange earnings, but what remains unanswered is how much these earnings, and other impacts of foreign investment, benefit the local economy. This wider question will be considered in chapter 7.

[38] Office rentals in Seepz are well under one tenth those in other parts of Bombay; being in the North of the city it is easy for staff to get to; and all utilities and other resources are already connected.
[39] See Poe (1987), Seepz (1988), TUL (1988), Dataquest (1990b), Dataquest (1990c), Dataquest (1990h), Dataquest (1990o) and Dataquest (1990bb).

Summary

Government export incentives are intended to compensate for anti-export bias and disincentives. However, as seen from preceding sections, software is unlike many other industries in the relation between export and domestic work. Whether onsite or offshore, India's software exports enjoy a considerable competitive advantage over potential competitors in developed and other countries. Software exports earn more revenue per worker for a company than domestic work; they are more profitable; present a larger market; and offer other attractions, such as the ability to upgrade skills, that the domestic market. cannot.

For offshore work, the higher costs of hardware, software tools, telecommunications and interest rates, which are partly the result of government protectionism, still allow a large competitive margin and significant profit levels which do not need to be compensated. Onsite work is even less affected. Thus, Indian software exports need no export incentives to encourage a move from domestic to export work; nor do they require compensation of high input prices. What prevents firms from opting for exports or from increasing exports is not the lack of incentives, but the presence of market constraints and barriers which need to be overcome.

The government has only partly perceived this as regards the incentives listed here. Some of these incentive measures have had some impact on the constraints affecting exports. For example, the simplification of procedures has reduced some bureaucratic constraints, and the provision of export credits and guarantees has reduced some financial ones.

The government has also kept the level of software-specific incentives quite low[40] and has reduced some of them during the late 1980s, so that export obligations have been raised while foreign exchange permits were reduced.

However, these were probably the wrong measures to address. Changing the level of export obligations and foreign exchange permits has only served to reinforce reliance on onsite programming services and to reinforce the performance gap between large and small companies. It would probably have been better to reduce cash compensatory support instead, since this has fewer 'side effects' than obligations or permits.

At least these measures have addressed the specific nature of software exports. General measures have not and this suggests agreement with Lucas (1988), who perceives 'serious

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[40] Cash compensatory support for software is lower than for other electronics exports, and other incentives such as replenishment and advance licences and duty drawback are not available (GoI 1987b).

doubts as to the efficacy of export promotion by across-the-board export incentive schemes or indeed of devaluation'.

2.4. Impact of export orientation on export-domestic links

India does not have an anti-export bias in software, it has a pro-export bias. This section looks at the impact of this bias on links between domestic- and export-oriented production. The findings suggest the need to redress the balance between export and domestic work.

Use of domestic-oriented production in export work

> "The ability to export software, is based on several factors, a very important one being domestic experience and expertise." (Roy et al 1990)

The facilities and features of the domestic market can be used in a number of ways by exporters[41], but this use is constrained by the domestic market shortcomings already described.

i. Track record. For companies trying to break into the export market and for those still new to exports, credibility and track record must come mainly from their achievements in the domestic market. While large domestic projects, such as those contracted out by government, can help, domestic work in general is not valued very highly by potential clients overseas because of their often-correct perception that it is of lower quality and simpler than that required in exports.

ii. Staff training. Many software export companies place their new recruits onto domestic project work in order to train them for a year or so. The companies are less worried if mistakes are made on domestic rather than export work, and staff will be pulled off domestic projects part-way through if an appropriate export assignment arises[42].

iii. Staffing buffer. In theory, domestic market work could act as a buffer to keep experienced staff occupied when they are between export contracts. However, most staff in this situation are put onto training or an internal development project. Only if there is a significant gap between export contracts will they be moved to domestic work. Such staff

[41] See also Saldanha (1983) and IDC (1988b).

[42] An unintended consequence has been to allow some domestic-oriented companies to pick up contracts from clients disappointed by the behaviour of these exporters.

often get bored with such work and quit, which is an incentive for companies to try to schedule continuous export working, at least for their most experienced developers.

iv. Financial buffer/base. Many companies, particularly smaller ones, engaged in exports find that as contracts come and go they have large variations in the level of earnings. They also find export revenue varying due to some of the vulnerabilities and constraints already mentioned. Such companies use domestic market work as a base of more continuous cash flow to smooth out these variations. For *example, TCS's annual export growth rates in the* 1980s have ranged from 19% to 81% in rupee terms but total turnover rates, which also include domestic earnings, have only ranged from 21% to 35%.

Domestic market work is also used to spread overhead costs and as a hedge against some future point where visa regulations, the international economic or political situation, or the attitude of the Indian government change and make exports an impossible or unattractive prospect.

Finally, many firms will not (or cannot) consider moving into exports *until* they *have* a domestic financial base.

v. Skills source. While the domestic market might be suitable for initial training of export staff, it is not a source for skilled export staff either in terms of numbers or quality (see, for example, Tilley 1990).

vi. Product source. For many countries, software products have been exported only after building a 'strong domestic presence' (Parpia 1990). But in India, there is little in the way of product innovation in the domestic market that could be used as the basis for exports. Many locally-developed applications and systems software packages are derivatives of imported products, with innovation limited to the addition of a few new features or to making the product run faster. Recent 'look and feel' court cases will prevent such packages being exported, at least to the US (see chapter 5 and Schofield 1990a). Those packages which are innovative tend to address India-specific areas such as Indian languages, Indian banking and accounting, astrology and homeopathy, for which there is little export market.

Secondly, as already noted, local standards of reliability, documentation and user-friendliness may not be an adequate guide to overseas standards.

vii. Wholly export-oriented firms.

> "How are software export units supposed to work in isolation without having anything to do with the local market?" (Computers Today 1987a)

Those firms which have no connection with the domestic market lack an obvious training ground for new staff. In such cases, the firms have to rely on persuading the client to undertake training (which is rare) or their parent company, or they have to use offshore or internal projects for training. This is one reason they have been keen to encourage offshore contracts. They may also try to rely more on hiring experienced staff. Whatever the case, they experience greater costs and difficulties than those firms with a domestic base.

To provide a financial base and buffer, export companies with no domestic sales have to rely on their foreign owners or collaborators or, more rarely, their domestic parent company. These firms also need foreign collaborations in order to guarantee a flow of export contracts but, without a strong domestic base, they are tied to fluctuations in the international market and their growth rates have been more variable than those of companies that have a domestic base.

Use of export-oriented production in domestic work

With few software products being made by Indian companies for export, there is little scope for such products to be fed into the domestic market. However, one way in which it was hoped to strengthen the domestic market was to have skills, quality standards and procedures learned on export work transferred to domestic-oriented work (see, for example, EI&P 1986b). In practice, this has not happened to any great extent.

Wholly export-oriented companies have had little impact - 'The domestic spin-offs of this kind of export effort are negligible' (Muralidharan 1988). Their staff are often well trained and become highly professional but, while they work for the company, they make no skill input to the domestic market. Some staff do leave, but the vast majority of them go overseas or continue export work in other companies.

Staff in firms with both export and domestic operations do pick up useful skills while on export work, including technological and application area skills, and general development skills relating to timetabling, quality standards, and communication with users. However, there is not a two-way flow of these skills, as one company manager made clear:

"There is one direction of people between export and domestic work, and that is from domestic to export and not vice versa."

Staff are trained on domestic work and then move on to exports but they rarely move back because, as noted above, it is difficult to move staff onto domestic work between export contracts. Staff like to carry on travelling overseas; they enjoy the higher earnings that export work brings (see IDC 1988b); and they often find export work more challenging than domestic work (EI&P 1985c, Widge 1990). Compounding all this are the high losses of those skilled staff who join the 'brain drain'.

Overall, then, there is remarkably little transfer of skills or working standards from export- to domestic-oriented work.

Summary

There is widespread agreement about the need for greater integration and balance between India's software export and domestic markets. Indeed, this is seen as a prerequisite for greater export growth.

"There has been an overemphasis on exports rather than on building an industry which could meet both internal demands as well as export requirements." (Kohli 1989b)

"... we may be rushing into an export market at the expense of the domestic one. Ignoring the fact that the domestic market, though beset with piracy and other problems, may have strong potential. And that countries who have become export powers have developed their domestic markets first - or at least concurrently." (Roy et al 1990)

"Significant software export performance can only be derived from strong domestic software industry. Therefore, there is a need of focus on integrated development of software for domestic and export markets together" (EI&P 1986b)[43]

Results presented earlier suggest that, in the short term, it is the weaknesses and not the strengths of the domestic market which are driving companies into exports. However, this section has also shown that exporters have benefited from links to the domestic market; that those who have no such links experience difficulties; and that weaknesses in the

[43] See also Krishna (1987), Nayyar (1988), Malhotra (1989c) and Nasscom (1990b). The need for balance between these two types of production is emphasised in a more general way by Schmitz (1984:15), Lucas (1988) and Weiss (1988:321).

domestic market constrain exports by providing poor credibility, skills, or basis for products.

This will continue unless both government and industry 'give a more serious look at the domestic software market in addition to exports.' (Malhotra 1989c). As one senior Ministry of Science and Technology official put it, 'At the moment, software is just hopping, and may soon fall over. ... Policy should allow industry to walk on two legs by balancing export and domestic markets'.

Domestic constraints need to be addressed - there is clearly a promotional role for government, given its control of a high proportion of domestic demand. If this is done, skills, quality, credibility and, perhaps, products can be built up within a large and well-informed domestic market (Kohli 1989b).

Greater integration and balance between export and domestic production is also required if skills are to be adequately transferred from exports to domestic market work.

3. Conclusions

During the 1970s and 1980s a global software market has come into existence which Indian firms take a share of thanks to low labour costs and available skills. However, it would be a mistake to see this as a 'free market', at least as far as the Indian firms are concerned.

They are faced by future threats to growth from automation, the substitution of goods for services, developing country competition, developed country protectionism, rising skill needs, and the dislike of contracting out. More importantly for the present, they are faced by many barriers which limit the opportunities for growth and for diversification away from poorly-paid, poorly-skilled exports.

As noted in chapter 1, the neo-liberal model would tend to play down the importance of such barriers and constraints, yet these have a very real impact on Indian firms. Government policy clearly has to address the constraints, and it is not clear that liberalisation presents the best solution. As will be argued later, multinationals can help but they bring other costs, while governments can only help by greater intervention and not by liberalisation.

The evidence here suggests that there will be a definite role for the Indian government in the stimulation of demand in the domestic software market. It has already been seen that an increase in state control and regulation - the introduction of copyright - has been a positive step towards this goal.

Further contradictions for the neo-liberal model are seen in its focus on price factors as being of prime importance. Through a full understanding of the complexity of the market for Indian software exports, it can be seen that price is only one among many other factors, which include quality, credibility, access to technology and other skills.

The neo-liberal model also advocates that policies should be economy-wide wherever possible. Yet the evidence from the use of export incentives shows the inadequacy of this generalist approach, which fails to deal with the specificities of software exports. In particular, and despite its place within a generally protectionist regime, the software industry has no bias against exports, but a bias in favour of exports. This being the case, sweeping policy prescriptions about export incentives are clearly inappropriate.

The Indian software industry presents a case of an industry which has gone beyond simple export orientation to 'super export orientation'. This has derived mainly from the nature of both export and domestic markets, but these have been partly affected by a policy which has always encouraged a focus on exports. In this case, therefore, state and market are not exclusive opposites on a continuum but act in concert to shape the industry's development and its export orientation.

Such an orientation has had damaging impacts on the overall development of the industry. The domestic market and domestic-oriented production remain stunted, while links between export and domestic production are weak, to their mutual detriment, leaving the export-oriented sector a virtual enclave, divorced from the rest of the Indian economy.

There needs to be greater integration and balance between these two markets and, in this, government policy has a role to play by more fully addressing the constraints that beset the domestic market, and by reducing other pro-export biases.

However, liberalisation cannot be rejected out of hand, as seen from the impact of liberalising industrial licensing. The effect has been generally regarded as positive, though only in terms that it has removed a previous impediment. This particular liberalisation (which is only one among many others which have to be assessed) has therefore been akin to opening one in a series of gates - it has been a necessary step, but one which, on its own, does not guarantee industrial growth.

Finally, the findings in this chapter stress the limited role that policy has had. The effect of form has often been as important as that of content and many external factors - policy of foreign governments, new technologies, changes in the global market, managerial and user attitudes - have had an impact on industrial development and an impact which, in many cases, domestic policy can do relatively little about[44].

[44] A point also made by Nayyar (1988).

CHAPTER 5
IMPORTS AND CONSUMERS

Introduction

In chapters 2 and 3 it was argued that policy is best analysed by focusing in-depth on particular policy areas rather than by trying to evaluate policy as a whole. From chapter 2, it became clear that changes to import policy form a very important part of the observed changes in software and hardware policy, and in technology policy as a whole[1]. In chapter 4, it was seen that one aim of import liberalisation was to overcome the technological constraints that beset the software industry.

The purpose of this and the next chapter is to assess the impact of import liberalisation on local consumers and producers of both hardware and software. This chapter concentrates on the impact on software industry consumers, while chapter 6 looks at the impact on local producers who are competing with imported goods. Many software companies fall into both categories since they are simultaneously consumers and producers.

It will be argued that import liberalisation has had a generally positive set of outcomes for consumers. It has helped overcome the technological barrier to offshore export contracts and has improved productivity, product quality and export levels. But, while the balance of trade situation within the Indian software industry has probably improved because of the import liberalisations that affect software companies, these same liberalisations have also affected a large number of other consumers in other industries.

From this broader perspective, import liberalisation has probably worsened India's balance of trade - not unexpected given the direct link between liberalisation and imports, and the indirect link between liberalisation and exports. The increasing use of new technology also brings a number of long-term dangers which threaten India's main form of software exports.

Import policy must, however, be kept in context. The nature of the technologies involved and of the global market, and other factors have all been important both in constraining available policy choices and in determining the impact of policy changes.

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[1] Raju (1988) also emphasises the centrality of import policy.

The technologies

As may be recalled from chapter 1, two principal technologies are involved in software production. Firstly, the software being produced requires hardware, in the form of a computer, on which to run it. Secondly, the software must be written in one of the many programming languages that are available.

Programming languages

There have been so far been four identifiable generations of software programming language technology. Examples of each are given in table 5.1.

Table 5.1

Examples of the first four programming language generations

1st generation -	011011 000000 000000 000001 110110
2nd generation -	ADD B
3rd generation -	X=(A+B)/(C+D)
4th generation -	LIST BY CUSTOMER AVERAGE (INVOICE TOTAL)

Source: Martin & Leben (1986:5-8).

All the generational changes have allowed programmers to become less concerned with the minutiae of *how* to undertake a particular task and more able to rely on statements of *what* is to be done, leaving the *how* part to the language. Fourth generation programming languages (4GLs) represent such a considerable step in this direction that they are described as 'software tools' which partly automate the software production process[2].

There are other software production technologies which could have been chosen as examples but these were either too little used in India at the time of research (such as computer-aided software engineering (case) tools which automate all stages of software production[3]), or were not sufficiently dissimilar to preceding technologies (such as report and screen generators). Unlike these others, 4GLs have become widely used in the Indian

[2] Greater depth of information about 4GLs as a technology can be found in Martin (1985), Grindley et al (1986), Martland et al (1986), Watts (1987), Comes (1988), Jones (1988a) and Butler (1989).

[3] 4GLs provide a subset of what case attempts to do and a number of 4GLs are now being expanded into case tools by including more 'upstream' stages of the software lifecycle. Thus, although 4GLs were the dominant technology at the time of writing, they should be seen merely as a 'staging post' on the road to almost complete automation of software production.

software industry in the latter half of the 1980s[4] and they represent the most important technological change in Indian software production during the 1980s.

Hardware

The three main classes of computer, in ascending order of power and performance, are microcomputers (often called personal computers (PCs)), minicomputers, and mainframe computers[5]. These categories are further broken down in a scale, as indicated in figure 5.1.

Figure 5.1

Hierarchy of hardware

Microcomputer
|
Supermicrocomputer/workstation
|
Minicomputer
|
Superminicomputer
|
Mainframe - Minisupercomputer
|
Supercomputer

In the 1980s, there have been two significant trends in computing (Schware 1989:7-8)[6]. The first has been the steadily decreasing price:performance ratio of all hardware thanks to various technical advances, such as the increasingly large scale of electronic circuit integration. The second has been the emergence and then market dominance of the microcomputer, particularly those which are compatible with IBM personal computers. By 1989, over 95% of the 100,000 or so computers in India were microcomputers, the great majority being IBM-compatible PCs[7].

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[4] Although the technology has been in existence since the late 1960s, use of 4GLs globally has only become significant in the latter half of the 1980s (see Grindley et al 1986:13 and Durham 1987).

[5] There is no absolute distinction between these three, and the 'boundaries' between them have become increasingly blurred.

[6] The growth of networked computers in the late 1980s will not be considered here.

[7] An estimate based on data in Dataquest (1989l).

1. Policy, import levels and use of the technology

This section looks at the extent to which import policy changes can be held responsible for the increasing import and use of the technologies described.

1.1. Software tools

Software tools policy

Prior to 1986, there was no stated policy on import of software tools and products[8]. Software was only imported as part of a complete 'computer system' and was therefore subject to the same import rules as hardware (ESC 1988:37).

Once a stable policy emerged in 1987, software still attracted a sizeable import tariff but its import was delicensed, that is, placed onto Open General Licence (OGL). Software exporters were also permitted to enter into agreement with a foreign producer to act as the Indian distribution, support and training centre for an imported software tool or product. These tools or products could be sold directly to any Indian purchaser for a rupee transaction. Despite the retention of an import tariff, the situation since 1987 represents a significant liberalisation compared to the situation before that time and, with 80% of Indian imports still requiring a licence (Wadhya 1988), one of the most liberalised import policies.

Levels of import and use

Fourth generation programming languages were first used by Indian software companies in 1982 but use remained low (Joseph 1983, Financial Express 1984b) until after the 1987 software policy, when distribution deals were set up for most of the globally popular 4GLs. Despite this, in the 1988 survey, only four of the top 13 software companies were using the new languages.

By 1989, the situation was very different with a strong rise in the visibility of 4GLs in terms of articles and advertisements selling them or seeking staff with relevant skills.

> "Today, vendors are not considered viable unless they offer 4GLs and users are not up-to-date unless they ask for 4GLs." (Mehta 1989)

[8] Though the government had recognised the importance of the former and had promised to liberalise imports in 1984 (EEPC 1985).

In the 1989 survey, 25 of the 31 companies asked about 4GLs were using them and the remaining six all intended to do so at some point in the near future. The degree of use had also increased, with the proportion of contracts involving 4GLs typically having doubled between 1987/88 and 1988/89. The proportion of all Indian computer users using 4GLs also increased substantially between 1988 and 1989, from 5% to 20% (IDC 1988a, IDC 1989a).

The vast majority of 4GLs being used were imported and it can be estimated from distributors that about US$1.5m worth of 4GLs were imported into India by distributors in 1988/89 compared to less than US$0.5m in 1987/88. In addition to these imports, the survey results suggest that there was also a rise in the level of imports undertaken directly by software companies using Open General Licence. The cost of OGL imports could not be quantified, but is likely to be less than distributor imports.

The import and use of this new technology in India therefore grew considerably in the late 1980s, suggesting some association with *changes in import policy.*

Impact of policy on access to software tools

Policy has had a role to play in facilitating access to the technology. As one company manager put it, 'Until that time [1987] we had not thought of importing any foreign software. It is only after the government has introduced the OGL system that we can take this route.'

Through piracy, smuggling, and import as part of a 'computer system', software companies were able to get access to 4GLs prior to 1987 but this access was distinctly limited and had the disadvantage either that it offered no training, support and updates, or that it required a government licence and was very costly. Following the 1987 policy, software companies have been able to buy software tools more cheaply and/or have been able to take advantage of support, training and updates either from the foreign producer or a local distributor.

The change in policy - both delicensing and the permission for local distributors - therefore seems to have been a necessary step before greater use of these software tools became possible within India. However, the time lag between the change in policy (early 1987) and a significant increase in the use of 4GLs (mid- to late-1988) suggests that other factors have affected access to and use of this new technology.

Impact of other factors on access

1. Distributors

Foreign suppliers have only been willing to enter into distribution agreements because an Indian law on software copyright exists[9]. Once such a distribution agreement is made, the Indian partner makes very little, if any, money from selling the actual 4GL since most of the revenue goes back to the foreign producer. Indian companies have been willing to take up distributorships only because they use the 4GL as a lever to further sales. Most sales to domestic customers are part of a package which includes the writing of some custom software for that customer using the 4GL[10]. Distributors also want to build up a relationship with the foreign supplier in the (as yet largely unfulfilled) hope that this will lead to export contracts from the supplier.

2. Skills and awareness

Existence of a technology is not a sufficient condition for it to be accessible - users must be aware of its existence and must be able to access the skills needed to use it, which they were not in 1987 (IDC 1987 Vol1:29). Indian distributors have improved access to the technology by increasing awareness and access to skills. Consumers are more aware of the technology because it has been strongly advertised and marketed. Partly, this is because the marketing departments of Indian firms come under pressure from both the foreign supplier and their own top management to get as many clients as possible in the domestic market to buy 4GLs.

Indian distributors have also improved access to 4GL skills through their training courses, though this has not been relevant to all consumers. For those in the export-oriented segment of the industry, skills and awareness have quite often been supplied by a foreign collaborator.

3. Technical factors

Since early 1986, microcomputers have increasingly outnumbered all other computers in India but, at that time, 4GLs were generally available to run on mainframes and

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[9] A point reinforced by Schware (1990a).

[10] In this way, Indian distributors have aimed to reap profits from their distribution monopolies - though the important element is their monopoly of skills rather than of sales. Distributors could therefore be described as "rent-seekers" since rents are the sums which accrue through attainment of a monopoly position or a position of ownership in a situation of scarcity. Such behaviour is also seen in the case of imported hardware, though associated with protectionism and scarcity whereas here it is associated with liberalisation and monopoly.

minicomputers and not on PCs. It was only in 1987, when PC-based versions of these products became available in India, that the majority of users could begin to consider using them, aided by the fact that PC-based versions were much cheaper than previous versions.

Therefore, the nature of the technology and of the local distribution deals have had a complementary impact to policy in increasing the accessibility of 4GLs to Indian consumers.

Impact of other factors on use

Reasons have been given above why *access* to 4GLs and 4GL skills has improved within India, but this does not necessarily explain why *use* of these software tools has increased. The most obvious reason for rising levels of use is that company managements perceive benefits which 4GLs can offer; this perception being enhanced by distributor marketing. However, there are other influences.

1. Management skills

The introduction and use of a new technology like 4GLs requires more than just giving a disk and a manual to a programmer. It requires considerable effort by management to change software production methods and staff attitudes to suit the new technology[11]. For example, it is generally agreed that a structured production methodology and production standards must be used with 4GLs on all but the smallest projects[12].

Yet, as mentioned in previous chapters, the Indian software industry has a shortage of good management skills. Although this does not affect the extent of use of 4GLs, it does hinder the *effective* use of the tools. India is not alone in this[13], but the management problem is particularly acute here (Plus 1989, Sridharan 1989). There is therefore a need for such skills to be built up within the Indian industry, yet this need is not addressed by import liberalisation.

2. Clients

For domestic-oriented production, the managers of software houses are 'pushed' into using the new programming language by the advantages that they perceive 4GLs can offer, but

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[11] A conclusion drawn from Bhabuta & Veryard (1986), Grindley et al (1986:5), Jones (1988a) and Computing (1989b).

[12] See Grindley et al (1986:78, 90-93), Holloway (1986:18), Martin & Leben (1986), Cornes (1987c), Watts (1987:22-23) and Schware (1990b).

[13] In 1989, for example, Computing (1989b) reported that only 20% of UK companies surveyed were making effective use of their software tools.

they are also 'pulled' by their clients who want them to use 4GLs. Within the export market, the latter influence is even stronger.

For custom-written software, '4GLs are becoming a strategic choice' (Sweet 1988a) of Western companies because of the productivity gains, greatly reduced maintenance costs and hardware independence they can offer. By the late 1980s, the great majority of US and UK computer installations had some kind of 4GL product in use (Cornes 1987a, Computing 1988a)[14].

This increased use and desire to use 4GLs obviously has implications for Indian software export firms which must follow this trend if they wish to remain integrated with the global market. When asked why they were using 4GLs on exports, Indian software companies typically replied - 'It was the client's choice'; 'Our clients were asking for 4GLs'; 'We were responding to the needs of the market place'. These companies are therefore being driven by client demand rather than their own choice and they find that 'To stay competitive, we have to offer the latest and widest range of tools and techniques to our clients, and that includes 4GLs.'

The improved access to 4GLs has therefore helped Indian software companies to address growing client markets at home and overseas. Although the Indian companies surveyed felt that, in theory, they could survive without recourse to 4GLs, by exploiting various niches in the 3GL market, none of them intended to do this because in practice it would be 'commercial madness', as one marketing manager put it. In fact, client demand for 4GL work has been so great in exports that it has outstripped supply, with a number of companies stating that they have had to turn down 4GL-based export contracts because they lacked sufficient staff with the requisite experience. Thus staff skills, as well as management skills, are a constraint to greater use of this technology.

Summary

Software tool import policy has been liberalised in India since 1987, and import and usage levels of these tools have increased substantially since that time. While import liberalisation was an important and necessary step towards increased access and use, it was not the complete cause. The time lag between policy introduction and increased use occurred because distributorships, marketing, awareness, skills and client confidence in Indian companies as a source of 4GL expertise all had to be built up.

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14 Until 1990, the exception to this was IBM hardware sites (Jones 1989a, Mill 1990) but the relatively small proportion of Indian export work on IBM hardware limited the impact of this.

Changes in the technology have also played a part and so have outside pressures. The coincidence of import liberalisation and the emergence of PC-based 4GLs was fortunate, as has been the technical link between 4GLs and the provision of custom software services. As one would expect in the case of import liberalisation in an export-oriented industry, use has increased partly because of pressure from foreign suppliers to sell and demand from foreign clients to buy. In the latter case, import liberalisation has helped the Indian software industry address a new, growing market.

While import liberalisation has been associated with the provision of basic skills to allow this technology to be used, it has not addressed the complementary inputs that new technology introduction requires - protection through copyright, finance, management and other higher-level skills, and marketing to make clients aware of new industrial capabilities[15].

Import liberalisation has therefore been akin to opening one among several gates[16] - it is a necessary part of improving access to foreign new technology, but it is not the sole cause. Nor should it be seen as the explanation for the fact that companies actually make use of this improved access. Import liberalisation alone cannot therefore be regarded as a comprehensive policy to address the issue of raising levels of use of new technology in a developing country.

1.2. Hardware

This section considers the relationship between import policy liberalisation and consumption of another technology - hardware - which is fundamental to software industry development.

Hardware policy

Software companies are affected by hardware import policy in three ways - directly by policy that deals specifically with hardware import by software exporters; less directly by general policy on hardware import by any Indian user; and indirectly by policy on the import and resale of computers or computer kits by Indian producers.

The principal changes in all three areas have already been described in chapter 2. In the 1970s, it was difficult to import a computer but easier to import as a software exporter

15 See also Schware (1990b).

16 An analogy also to be drawn from the work of writers such as Narasimhan (1984:79) and Alam (1985).

than otherwise. Between the late 1970s and 1984, it was a little easier to import computers but harder for software exporters after 1981. In late 1984, there was significant liberalisation of hardware import policy in all three areas. In terms of procedures and implementation, this liberalisation has continued during the rest of the decade, particularly affecting software exporters. In terms of tariffs and export obligations, policy has either remained static or been somewhat reversed since 1986.

Levels of import and use

Indian software companies have been using hardware for as long as such companies have existed. Published figures on their use of hardware are scant[17] and only exist for hardware import by software exporters. These indicate that such import first began in 1974 and grew to about 20 machines per year by the turn of the decade, with software exporters accounting for as much as half of all computer imports. From 1982 up to 1984, imports steadily declined because of fears of misuse, as noted in chapter 2.

Figures were not published after this time but information from government officials indicated that imports had increased quite considerably after 1986. At a very rough estimate, about 35 software export firms imported hardware in 1987 and 1988, with around US$9m-worth being imported in 1987 and US$14m-worth in 1988[18].

Figures on overall computer imports are more extensive for hardware than for software tools and are shown in table 5.2.

Table 5.2

Indian Imports of computers and related items

Year	Imports (US$m)
1981	18.4
1982	25.3
1983	17.9
1984	69.8
1985	124.3
1986	158.7
1987	55.8
1988	154.3
1989/90	69.7

Source: DoE annual reports, Shekhar (1988), Mehta & Shivdasani (1989) and Dataquest (1990w).

17 The figures used here are taken from DoE annual reports and EI&P (1985a).

18 This compares, for example, to six software firms importing US$1-2m-worth of hardware in 1983.

Despite the fluctuations in the 1987 and 1989/90 figures and the fact that these figures provide only a rough guide[19], there does seem to have been a substantial increase in imports comparing the situation before and after 1984.

Until 1984, software companies, particularly those engaged in software exports, bought little locally-produced hardware according to interviewees. In the second half of the 1980s, however, this changed with most companies (at least those outside export processing zones) tending to source all their microcomputers and even some minicomputers locally[20].

With software company imports falling in the early 1980s then rising after 1986 and with general hardware imports and local sourcing both rising after 1984, this suggests a strong association with policy changes.

Impact of policy on access to hardware

Hardware is unlike software tools because import is and always has been largely controlled by government licence, and because hardware is much less easy to smuggle or pirate. Therefore, even more than in the case of software tools, the liberalisation of import policy has been of importance in facilitating access to imported hardware. Thanks to changes in procedure, to reductions in tariffs, to the re-introduction of foreign computer system loans, and to initiation of a 'fast-track' scheme of imports via the ExIm Bank, access to imported hardware became easier and cheaper for all software companies after 1984 and for software exporters specifically after 1986.

While liberalisations improved access, protectionism and controls had the opposite effect. Changes to government regulations after 1981 until 1984 had a dramatic effect in closing off access to hardware imports. Similarly restrictions on imports that continued after 1986 - requirement for an import licence, high export obligation, delays in import procedure, difficulties with Customs officers over definitions of 'computer system' - have reduced access to imported hardware and driven some companies towards different forms of production which do not require local access to foreign hardware.

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[19] The figure for 1987 is low mainly because of the financial constraints imposed after the major drought of that year, while it is unclear whether the figure for 1989/90 applies to exactly the same category of imports as in preceding years. Figures for 1981 and 1982 are more of an approximation than the others and none of the figures shown includes those (probably relatively limited) imports which came in on Open General Licence.

[20] Economy-wide levels of computer use have also risen with the installed base increasing from around 1400 computers in 1980 to 4000 in 1985 and over 100,000 by mid-1989 (Bhatnagar 1986, Kaplinsky 1987:37, Dataquest 1989l).

Import liberalisations have also increased the accessibility of locally-produced hardware, with the sanctioning of computer kit imports helping to fuel a substantial increase in the availability of microcomputers that could be bought in local currency and with liberalisation also helping to reduce the price of these goods (see below).

As with software tools, though, factors other than policy have also played a role. Access has been affected by the willingness of local firms to set up production; the availability of hardware-related skills and awareness; the availability of foreign exchange; and by technical factors such as the ease of installation and use and low component cost of microcomputers (and the difficulty of smuggling and piracy).

US as well as Indian government policy has had an effect on access. US export restrictions in the early 1980s helped keep offshore software exports from India low (Dataquest 1984d, EPW 1984b). Even in the late 1980s Indian importers were required to give assurances to the US government about use and resale of imported hardware (Elsoftex 1989a) and exports of powerful computers were delayed or blocked (Foremski 1989b). A recent US ban on the hiring of software may also limit the utility of Indian rules about the loan of computer systems to Indian companies (Computing 1990b).

Impact of other factors on use

Import liberalisation and other factors have helped improve software company access to computers, but why have imported and local hardware purchases increased since the mid-1980s? The question is particularly pertinent since it has already been seen that companies can produce software on their client's computer without needing to buy one of their own.

1. Domestic leasing of imports

When a resource is scarce, ways are always sought in which to obtain that resource for profit or other gain. Thanks to tariffs, quotas and licensing, access to large foreign computer systems has generally been costly and difficult in India, thus making these systems a scarce resource. Companies have used the regulations on hardware import for software export as a means to bypass these restrictions and provide hardware for the domestic market. Such companies locate a local business organisation which needs a new computer system, import the system on the pretext of using it for software exports and then, instead, lease it out to the local business organisation[21].

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[21] See Financial Express (1984a), Khanna (1984), Cleetus (1986) and Dataquest (1986a). Like the 4GL distributors, such companies (who are often distributors as well) are rent-seekers. It could be argued that

Judging by the number of company names listed in DoE annual reports as importers between 1975 and 1980 which never surfaced in software export figures, one can estimate that about 70% of imports at that time were by those who merely misused this relatively more liberal import channel with no serious intention of carrying out software exports. After 1981, the government clamped down, temporarily closing off this practice, but it was re-opened after the policy liberalisation of 1984 which again made hardware import for software export easier and cheaper than 'ordinary' hardware import.

There were, however, two main differences comparing the late 1970s and the late 1980s. Firstly, thanks to policy changes in 1981 and 1986 (and 1988 for large companies), software company use of imported hardware for domestic purposes was legitimised. Secondly, there was an increase in the penalties for those who failed to export after having imported a computer. This import mechanism, and attendant leasing to domestic users, has therefore metamorphosed from a bypass to be misused by 'quick-buck fast operators' into a legitimate benefit to be enjoyed by legitimate software exporters.

The growing range and power of locally-produced hardware has eaten into this behaviour (Nasscom 1990b) but it remains a useful source of domestic revenue to a number of software companies, particularly in relation to IBM computers (which have not been produced in India since IBM's 1978 pullout).

2. Client demand

If Indian software companies perceive sufficient foreign client demand, they may be encouraged to import hardware and use it for export work, or to take advantage of the regulations on loans of foreign computer systems. This process remains subject to the factors described in previous chapters which affect the securing of offshore export contracts - credibility, available telecommunications, and uncertainties about Indian and foreign policy. Software companies are also buying more local hardware to address perceived export markets for microcomputer custom software and domestic markets for microcomputer package software.

As with software tools, hardware import liberalisation has therefore helped companies to address a wider range of markets.

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lobbying by these companies to improve their access to software tools and hardware had little to do with trying to aid their exports (though it was a necessary step in that) and more to do with rent-seeking.

3. Other factors

Local hardware is also being bought by software companies because of government rules on tax write-offs and depreciation of computer equipment (ESC 1988:24). Management and staff skills are an issue but less so than with software tools. Training in basic (though not higher) skills for running hardware will be given by the supplier, while management skills are associated with the introduction and use of software applications which run on the hardware rather than the hardware *per se*. Finance is still required by those buying new hardware.

Summary

Hardware import policy of relevance to software companies was liberalised in 1984 and 1986, though changes in policy procedure and implementation have been as important as changes in written policy. The import, local purchase, and use of computers have all increased substantially since that time.

Even more than was the case with software tools, policy has affected access and use, with liberalisation increasing it while past and continuing protectionism and controls tend to restrict it. Import liberalisation has also helped to widen the markets addressed but still does not intentionally address the complementary issues of skills and finance. Nevertheless, policy is again not a complete explanation, with awareness, technical factors, foreign exchange availability and US policy also having affected access.

Overall conclusions reinforce those about import liberalisation and fourth generation programming languages. Import liberalisation is again like opening a gate - it improves access and is necessary for increased use, but does not explain the latter. Computers are <u>bought</u> partly because companies can make money from (recently legitimised) domestic leasing and from the benefits of depreciation. Such machines are increasingly <u>used</u> because of client demand and because of all the factors that encourage offshore working - cost savings, client trust, relative policy stability in India, and fear about US visa restrictions.

2. Impacts of import liberalisation

Import liberalisation has played a necessary, though partial, role in improving access to new technologies for the Indian software industry which, in turn, has allowed greater use of these new technologies. A number of other extrinsic factors which affect consumption of new technology - such as skills and finance - have been discussed above, on which import liberalisation has had limited impact. However, import liberalisation does affect three factors intrinsic to the technology which are of prime importance to consumers - price, age, and quality of technology (from Verghese 1986) - and it would appear to have played a generally positive (though again only partial) role in improving all of these.

Price

For directly imported software tools and hardware, price is determined by initial product price (largely independent of Indian policy) and import duties, plus the cost of procedural time and effort. Given this, it is not surprising that import liberalisation has been quite directly associated with a reduction in the price and associated costs of these technologies, though the liberal policy on devaluation has counteracted this. Conversely, continuing interventions, mainly in the form of duties, help to keep the price of imported technology high[22].

The price of locally-produced hardware has also fallen dramatically during the latter half of the 1980s, as table 5.3 indicates. It shows prices for a bottom-of-the-range PC with two floppy disk drives[23].

Table 5.3

Indian microcomputer prices (US$)

Date	Indian price	Ratio Indian:UK price
1982	$32,000	>7:1
1983	$20,000	
Mid-1984	$10,000	3.5:1
Early 1985	$7000	
Mid-1985	$4000	
Mid-1986	$2300	1.9:1
Late 1986	$1500	1.2:1
Late 1987	$1800	
Mid-1989	$2000	2.0:1
Mid-1990	$1000	1.2:1

Source: British and Indian computer journals, Ravirajan & Jaikumar (1987), Pawar (1989) and Dickinson (1990).

22 See, for example, Kumar (1987).

23 The prices shown underestimate the extent of change, since the computer in 1990 would have more memory, better operating software, a faster processor and better monitor than that in 1982. The steady devaluation of the rupee over this period has meant that rupee prices in India have dropped proportionately less than the dollar price.

The final price is a function of three main elements - the initial price of the parts or kits (most of which are imported); government import and sales licences, quotas and duties[24]; and the willingness of firms to cut profit margins - and all of these act in combination. The first and last factors are also strongly affected by inter-firm competition and by projected market size[25].

Prices fell between 1982 and 1984 partly thanks to reductions in government taxes and duties, and partly due to falling world prices which, in turn, were partly due to standardisation on the IBM-compatible PC (Dataquest 1983b, Business Standard 1984, Dataquest 1985). However, the most dramatic falls came when the Indian hardware industry cut prices in an effort to stimulate demand, which dropped off almost completely in 1984 as buyers postponed purchases until they had full details of the new computer policy (Economic Times 1984, Pawar 1987a).

Lower prices helped build a large market which, in turn, allowed unit costs to fall. Substantial purchases by the government and public sector also played a very significant part in expanding market size and in creating a positive spiral of falling prices and growing markets until 1986 (Mahalingam 1989, Dataquest 1990u). Prices then rose as companies raised profit margins and government raised taxes and duties (Hutnik & Jaikumar 1988, Joseph 1989).

Prices continued rising between 1987 and 1989 because of currency devaluation, rising government duties and a global increase in chip prices and they were only offset to some extent by a reduction of profit margins to around 5% (Dataquest 1988d, IDC 1988a, Kalra & Khan 1988, Kalra 1989a). When the public sector company ET&T bought in materials for a production volume of 100,000 units in late 1989 it was able to substantially undercut all other producers, forcing them to reduce their prices and profitability too (Chengappa & Das Gupta 1989, Dataquest 1990d, Dataquest 1990l, Malhotra 1990).

In summary, import liberalisation can only be seen as a partial explanation for falling prices, with the permission for computer kit import, removal of quotas, and reduction in import duties all having some impact. However, government import policy is not the *whole determinant, with policies on other taxes, on devaluation*, on industrial capacity licensing and on demand, and with technical change and other factors within the global and domestic market more strongly affecting price (see Dataquest 1983b, Business Standard 1984, Economic Times 1985a, Jaikumar & Krishna 1987, Jaikumar & Hutnik 1988).

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[24] For example, import duty made up a little under 20% of the final cost of a PC in the late 1980s, while excise duty and sales tax made up just over 15% (GoI 1987e, Malhotra 1989d).

[25] For example, the unit price of materials drops by more than one third if one aims to sell 40,000 compared to 1000 PCs (Polavarapu 1989b). See also Polavarapu (1988) and Chengappa & Das Gupta (1989).

Technological lag

During the 1980s, there has been a steady reduction in the extent to which goods used in the Indian software industry - imported software tools, imported hardware, locally-produced hardware - have been technologically lagging behind those used in the US and Europe.

From interviews, media reports and advertisements one can see that the latest versions of software products, including software tools, are now released in India soon after their release in the US, whereas in the early 1980s only basic and rather outdated versions of software products were in use. Levels of use of up-to-date software tools still lag behind levels in the West but this reflects the management skills and priorities in India, not access to the technology.

Imported hardware has also come up-to-date. In the early 1980s, typical imports were of DEC PDP 11/44s of late 1970s vintage or second-hand IBM 370s of early 1970s vintage (GoI 1982:135, GoI 1983:137). In the late 1980s, Indian companies were importing IBM AS400 minicomputers only a few months after they were released in the North American market. Growing user sophistication and awareness have encouraged this process but import liberalisation has been a necessary part, particularly a reduction in the time lag imposed by bureaucratic procedure from more than two years in the early 1980s (Grieco 1982:45, EPW 1984b) to two-three months by the late 1980s (Interviews).

The technological lag of locally-produced hardware can be measured from the difference between the time a processor is first introduced into a computer in the US and the first use of that processor by an Indian manufacturer. As table 5.4 shows, the technological gap in microprocessor use has come down considerably during the 1980s.

Table 5.4

Time lag in use of US microprocessors in Indian computers

Microprocessor	US introduction	Indian introduction	Time lag
Intel 8085	1976	1980	4 years
Intel 8086	1978	1981/82	3.5 years
Intel 80186, Motorola 68000	1982/83	1985/86	3 years
Intel 80286	1984	1986	2 years
Intel i386, Motorola 68020	1986	1987	1 year
Intel i486	1989	1989	None

Source: Interviews, Shekhar (1988), Chellam et al (1989) and Tandon (1989a). See also Jaikumar & Hutnik (1988).

Indian companies had actually drawn ahead of the rest of the world by 1989. The world's first i486-based computers were exhibited at the September 1989 Computer Society of India show in Bangalore by the Indian companies DCM DP and Wipro IT Ltd, while US manufacturers waited for the November 1989 Comdex show in Las Vegas (Chellam et al 1989, Tandon 1989a).

Once again, growing user sophistication and awareness, as well as product standardisation and marketing have spurred on the closing of the technological gap, but import liberalisation has helped it to take place by allowing and encouraging local producers to upgrade the technology of their products in line with global trends.

Quality

The ability to access genuine imported software products is clearly to be preferred to reliance on pirated versions with poor manuals and no support. Liberalised access to imported spares has also helped to improve the reliability of imported hardware.

There is a general feeling (Hutnik & Jaikumar 1988, Jaikumar & Hutnik 1988, Kumar 1988) that local hardware is of a poorer standard than that made overseas, though this is confounded somewhat by the ability of Indian-made computers to compete in export markets and by the results of annual maintenance surveys by the journal Dataquest. Any link to import liberalisation is unclear since some sources (GoI 1987e) blame poor quality on excessive levels of government control and import protection, while others (Jaikumar & Krishna 1987, Malhotra 1989a) blame it on the existence of too little government control and too much competition.

Summary

As the 1980s progressed, the Indian software industry was able to use technology that cost less and which was more up-to-date and, to some extent, of better quality than previously. What has been the contribution of import liberalisation to these changes?

In the case of directly imported software tools and computers, there has been a strong link between import liberalisation and these improvements, though global technology standards and falling world prices have also played a part. For locally-produced hardware - which has a high import content - import liberalisation has helped the changes but only been a relatively limited factor. Other liberalisations - on excise duty, sales tax and industrial licensing - have contributed to price falls, but devaluation (also regarded as a liberalisation) has counteracted them, thus indicating the problem of using devaluation as a sweeping measure in conditions of high import intensity.

At the same time, government intervention through widespread purchasing was the driving force behind the expansion in the local hardware market which directly encouraged lower prices, greater competition, and indirectly led to greater marketing efforts and user sophistication[26]. These elements of the local market and those within the global market already mentioned combined with the growing technological capabilities of some firms to help bring locally-produced technology up-to-date and down in price.

Import liberalisation has therefore played a positive part in price reduction and technological updating but other factors have also contributed, sometimes with greater effect than import policy.

3. Impacts of increased use of imported technologies

It was reported above that import controls acted as a 'gate' to use of imported technologies, with liberalisation being a necessary though not sufficient step in increasing use of such technologies. Had import liberalisation not taken place, it is unlikely that use of these technologies could have risen. It therefore seems pertinent to ask what impact the increasing use of these technologies has had.

26 See also Shekhar (1987).

The government has intended that productivity, competitive advantage, quality and exports would all be improved:

> "The government seems to have further convinced itself that liberal imports of raw materials and components as well as machinery for technological upgradation and improvement of quality for the Indian industrial sector in general and for industries identified with high export potential in particular would tend to improve the international competitiveness of these industries and ultimately lead to increased exports in line with the principle of dynamic comparative advantage of India in world markets." (Wadhya 1988)

In this section it will be seen whether the imported technologies have had the desired effect.

When discussing the impacts associated with any new technology, it should be borne in mind that these impacts do not always and necessarily flow from the introduction of the technologies. Technology presents opportunities and choices; choices which are made by human, usually managerial, intervention. Though certain impacts are so frequently-observed that they come to be directly associated with the technology, one should always remember the proviso that it is a combination of humans and technology, rather than just technology, that determines the outcomes of technology introduction[27].

3.1. Software tools

Hardware has been a continuing presence in software development, but the introduction of new software production technology has been quite a significant agent for change. It has affected productivity (with a knock-on impact on competitiveness and employment), skills, quality, barriers to entry, and export levels.

Productivity

Advertisement claims that 4GLs can bring about a 'ten-fold' increase in software development productivity are overstated[28]. Indian companies generally found that 4GLs had no impact on the effort required for analysis, little impact on design, but reduced coding and testing effort by approximately 70% compared to development using a third generation programming language (3GL). While this figure could be achieved on

27 This issue is dealt with in greater depth by Boddy & Buchanan (1984), Kaplinsky (1984a), Schmitz (1985), Armour (1986), Rowe (1986) and Bagchi (1988).

28 Misra & Jalics (1988) also indicate the need to be realistic about likely productivity gains.

programming contracts (which involve only coding and testing), turnkey contracts involve analysis and design as well. Taking the overall software development lifecycle from analysis to implementation, coding and testing are felt to represent at most about half the total effort (Interviews, Brooks 1975, Cornes 1987b). In this case, 4GLs reduce overall software development effort by about 35% compared to a 3GL[29].

Even this improvement was not achieved at first by software companies, which found that initial 4GL projects considerably overran their project milestones. This was due to exaggerated expectations generated by 4GL marketing literature plus a prolonged learning curve for both developers and managers when using 4GLs, with an adequate depth of experience being gained only after several months of use[30].

Competitive advantage

By being more productive, 4GLs can reduce the amount of labour input required in the software development process while their relatively high cost increases the capital input required. This decrease in the labour intensity and increase in the capital intensity of production erodes the absolute and relative competitive cost advantage that offshore production in India currently enjoys within the world market because this advantage relies to a large extent on low labour costs (though the competitiveness of onsite working is not greatly affected).

The more automated production becomes, the greater will be the reduction of the Indian software industry's advantage. So, the industry is caught in a double bind. It must use the new tools in order that its own production costs fall along with those of competitors and in order to address the growing market for tool-based production. Yet this use of tools to maintain competitiveness will ultimately lead to a loss of competitiveness.

For the moment, though, any erosion of competitive advantage is counteracted because of the severe shortage of software developers with 4GL skills in the US and Europe. The consequence has been that pay levels for 4GL-skilled workers in these places rose well above those for 3GL-skilled workers in the last years of the 1980s (Computing 1987, Samson 1989). In India, there was no such pay differential because staff tend to remain generalists rather than specialists. With 4GL-related pay having risen in the West but

29 This overstates the productivity gain because most current 3GL projects use 3GL-based software tools such as screen and report generators. Survey results indicated that such tools required roughly 25% less effort for coding and testing than using a 3GL alone, equivalent to a 12.5% reduction for the overall lifecycle. 4GLs were therefore only 26% more productive for Indian companies than previous tools; an improvement of similar size to that reported by companies in developed countries (Jones 1988b).

30 Grindley et al (1986:72-73,96) and Verner & Tate (1988) both highlight the importance of time to learn.

remained static in India, any loss of competitive advantage was compensated, at least in the short term.

Jobs

4GLs are more productive than previous software tools and so, for a given output of software, less labour will be required. In the long term, 'The programmers' days are numbered as new technologies succeed in generating computer codes automatically' (Tilley 1989)[31], and analysis and design work too are being steadily automated by computer-aided software engineering (case) technologies.

However, for the foreseeable future, it seems likely that the gap between demand for and supply of software labour will continue to grow both in the West and India (Schware 1987, Schware 1989:8, Madden 1990, Roy et al 1990). The impact of 4GLs will be to create a rather gentler upward slope on the labour demand curve than would otherwise be the case, which will be beneficial rather than harmful to India, at least in the medium term (IDC 1988a).

Skills requirements

Table 5.5 shows the changes in relative effort required when using a 4GL as compared to a 3GL. The figures are expressed as a percentage of the overall development effort.

Table 5.5

Comparative software development effort when using a 3GL and a 4GL

Task	3GL	4GL
Analysis	6%	24%
Product design	18%	33%
Detailed design, coding and testing	76%	43%

Source: Verner & Tate (1986).

Because coding and testing are less-skilled tasks than analysis and design, 4GLs can therefore lead to an average upskilling of the software development process compared to 3GLs. Yet the main skills bottleneck for the Indian software industry is not 'a shortage of

[31] The link between software automation and job losses is also made by Grindley et al (1986:82), Schofield (1987) and Jones (1989a).

programmers to write programs but a shortage of quality analysts able to decide what a business was all about and how best to represent it in computing terms' (Cane 1987a)[32].

Use of 4GLs is therefore likely to aggravate the existing shortage of most highly skilled software developers while, in the longer term, 4GLs' automation of programming tasks may force Indian exporters to increase the proportion of turnkey contracts they undertake if they are not to lose business[33]. The greater emphasis on interactional, rather than technical, skills within a 4GL environment (Grindley et al 1986:82, Jones 1989a) will also act to the detriment of the Indian software industry because the strength of many Indian software developers has lain much more in the latter than the former.

Software quality

4GLs are easy to use, have error-scanning mechanisms, default options and self-documentation which ensure certain basic quality standards (Martin & Leben 1986). 4GLs are also strongly associated (Jones 1989b) with the software development technique of prototyping which is an iterative process of 'building and refining a working model of the final operational system during the development process.' (Holloway 1986:18). Use of prototyping helps to address some of the problems of normal development techniques such as mismatches between user and developer understanding, and the inability of users to judge needs and detect errors unless they see a working system (Arora 1988)[34].

Some of the productivity gains that 4GLs offer can also be 'traded in' to allow time for qualitative improvements to the final product. Feature enhancement, improved user-friendliness, or improved testing of existing features, all help to ensure greater product quality than might otherwise be the case as 'the programmer devotes more thought to the problem at hand and less to the coding' (Daniels & Yeates 1988)[35].

As a result of all this, 4GLs can be used to create 'applications of a greatly increased quality ... [which] meet users' needs and typically have far fewer errors, both technically and in terms of their match to business reality, than comparable systems written in any other way' (Jones 1989a)[36].

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[32] See also Kumar (1988).

[33] The danger of automation to developing countries is also noted in Schware (1987) and Schware (1990a).

[34] Prototyping is also associated with a re-integration of job roles. 'The separation of systems development staff into analysts and programmers is usually abandoned.' (Grindley et al 1986:5) and a new category of 'analyst-programmer' arises. While this has created certain problems for managers and workers (Grindley et al 1986:82, Watts 1987:80, Jones 1989a), it was too early at the time of writing to determine the effect on the Indian software industry because prototyping was not greatly used as yet.

[35] See also Watts (1987:81).

[36] The link between software tools and output quality is also made by UNIDO Secretariat (1983:20), Cornes (1987c) and Jones (1988c).

Entry barriers

Import liberalisation allows access to new technologies. However, such technologies are frequently more capital- and skill-intensive than those they replace. The greater ease of access that import liberalisation allows may therefore be mirrored by a greater difficulty for smaller firms wishing to break into the market because they lack the necessary resources.

In the mid-1980s, it was true that 'new productivity tools ... have tended to raise the absolute capital requirements for competitive entry into the software industry' (O'Connor 1985) because they were non-standard and cost tens of thousands of dollars plus training costs, compared to the generic, standardised 3GLs which were often given away free with the hardware and for which many skilled staff existed. 4GLs also required more hardware resources (memory, processor speed) than 3GLs (Grindley et al 1986:84, Jones 1988a) and heavier use of those resources by software developers (Gibert 1986:238, Watts 1987:118).

Large companies could therefore afford the new technology more easily and spread the cost over a number of large projects. It was also the large companies which set up distribution arrangements with foreign suppliers, as a result of which they were often provided with 4GL software and/or training free or at a reduced price.

However, after 1987, this situation changed mainly because of the advent of PC-based 4GLs. These cost relatively little (c.US$2000) as did the hardware to run them (though this was still beyond the reach of the very smallest companies). These 4GLs were also portable across a range of hardware platforms. This has meant that Indian companies with only a microcomputer can develop 4GL-based software on that computer and then quite easily transfer it to a client's minicomputer or mainframe. Skills, too, have become more portable so that Indian companies can compete for a client/hardware range somewhat wider than that for which their staff have direct hardware experience.

Companies concentrating solely on onsite export work do not necessarily have to purchase a 4GL and they have been able to build up 4GL skills either by hiring staff who already have such skills, or by getting clients to train their staff (see Samson 1989).

In summary, while 4GLs favour large companies with foreign collaborations and normally increase the capital and skill intensity of production, there are ways for firms to avoid having to pay directly for these production changes and, by their portability, 4GLs actually reduce entry barriers into certain markets. The proof of this is in the wide range of Indian firms, both small as well as large, which were undertaking 4GL-based work by the end of the 1980s.

Exports and the balance of payments

Import liberalisation is often associated with balance of payments difficulties, though such an outcome is not unexpected, particularly given the 'flood in, flood out' plan for software described in chapter 3 which aims for import-led export rather than exports predicated on local sourcing.

> "It [Indian government] has taken a calculated risk of facing increased imports, especially of imported capital goods in the short run, for reducing the balance of trade deficit in the long run through efficient import substitutions and efficient export promotion over time." (Wadhya 1988)[37]

It has been shown above that imports of software tools rose following, and partly as a result of, import liberalisation, from about US$0.5m plus OGL imports in 1987/88 to about US$1.5m plus OGL imports in 1988/89.

Most of the distributors' 4GL sales have been to domestic companies outside the software industry. One may assume that use of 4GLs will improve these domestic companies' efficiency and may help to create better software systems more quickly, which will in turn improve their overall business performance and exports, if they are exporters. It is quite impossible within the confines of this study to gauge the size of this effect, but the impact on non-software exports is not likely to be very great because the export-intensity of Indian industry is, in general, quite low (Guru 1988, Nayyar 1988) and because most Indian computerisation has been confined to office activities rather than production (IDC 1990).

One would expect, from the discussion above, that 4GLs ought to help increase software exports because they increase productivity, quality and the range of markets the exporter can address. Certainly, the level of 4GL-related software exports seems to have increased with the proportion of contracts involving 4GLs roughly doubling between 1987/88 and 1988/89 to around 15%, according to the surveys.

Thus, while roughly US$2.2m worth of net software export earnings involved 4GLs in 1987/88, the figure for 1988/89 was US$6.5m. Of this figure, about US$0.5m in 1987/88 and US$1.6m in 1988/89 would have come from offshore work which required

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[37] See also Singh & Ghosh (1988). The extent to which imports encourage or hinder import substitution, as suggested in the Wadhya quote above, will be discussed in chapter 6.

the software company to obtain a 4GL. One cannot tell to what extent other exports would have substituted for these if 4GLs had not been imported. Nevertheless, it seems certain that the software exports created by 4GLs fully compensate for the import of these tools by Indian software companies and may compensate for the total 4GL import bill.

The longer-term impact of new technology on India's software exports is not likely to be so beneficial. The dangers to competitive advantage and to programming services have already been mentioned, and contracting out also appears threatened. In chapter 4, it was noted that IT managers do not like contracting out but that they are forced to do so by top management strategies and other factors. Software tools may be altering this, so that 'companies are changing focus from hiring in programming expertise to tackle their applications development towards buying more 4GLs and productivity aids' (Price Waterhouse/Computing 1988)[38]. This provides a further long-term threat to India's custom software export 'monoculture'.

The linkage between software tools and products creates another difficulty. In mid-1986, it was the intention that software import liberalisation would cover software tools such as 4GLs and systems software but not software packages such as word processors or spreadsheets (EI&P 1986b). However, during subsequent discussions it became clear that any differentiated policy would be unworkable because both policy makers and implementers would have great difficulty deciding what was a software tool and what was a software package[39] (Malhotra 1987). With the import of software packages as well as software tools therefore having to be liberalised, overall software trade registers a deficit, as noted in chapter 3.

3.2. Hardware

The increased import of computers and of computer kits or components for locally-made computers has had less of an impact on the Indian software industry than software tool imports. The impacts listed in relation to software tools will therefore be covered only briefly for hardware.

Type of hardware has no real impact on factors such as productivity, employment or software quality. The acquisition of hardware-specific skills is likely to be improved by freer access to imported hardware and, as noted in chapter 4, use of hardware in India is a necessary element of any attempt to increase the amount of work done offshore.

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[38] Pawar (1987b) also suggests this may be a danger.

[39] An example given was that of *dBase* which can be categorised as a database package or as a tool for building databases.

Use of cheaper computers which are up-to-date with world standards allows Indian software firms to compete more readily in the global software market and also reduces costs for domestic-oriented production. The lower prices and greater power of computers, coupled with the emergence of operating systems (such as CP/M, MS-DOS, Unix) which are portable across different hardware platforms has also helped small firms enter into software production. The massive rise in PC usage in India (thanks to a combination of government demand, import liberalisation, technical changes and falling world prices) created a large potential market and triggered the creation of hundreds of small software companies.

As was the case with software tools, hardware imports rose following, and partly as a result of, import liberalisation. Most of these imports went to non-software companies and should have had some impact in improving the efficiency of local companies and exporters, with an unknown but probably not very great impact on non-software exports.

As regards hardware imports by software exporters, government intervention to impose export obligations generally ensures that the cost of imported hardware is more than recouped in export earnings by software companies. However, since most of those earnings come from onsite work and since the imported hardware may be leased out rather than being used for exports, it is not possible to put a figure on any increase in software exports which may have resulted from the increased import of hardware.

Import substitution of hardware has been much greater than that for software tools and there have been some hardware exports, as will be discussed in chapter 6. Despite this, there is still a negative balance of trade in computers (see also Mukhi & Chellam 1988) and, if one expands this to include all electronics goods, there has been a negative balance of trade of several hundred million US dollars every year in the last half of the 1980s (DoE annual reports, Raju 1988, Dataquest 1990i, Premkumar 1990).

3.3. Summary

Import liberalisation has allowed Indian software producers greater access to the global standards of new technology and related skills. This has been particularly important to exporters, who must compete in the world market. Confining one's view to the export-oriented segment of the Indian software industry, the imports of software tools and hardware appear to have more than paid for themselves in helping to generate additional exports, though partly thanks to the strong export-oriented base already created which could take advantage of these imports.

However, for technical, political and bureaucratic reasons, such imports have not been confined to these technologies or to this industry segment. In this wider setting, import liberalisation of information technologies has helped to increase India's balance of trade deficit and the country has not been able to 'ride it out' while awaiting a generalised improvement in export performance (Mahalingam 1989).

In the Indian economy as a whole, import liberalisation increased the trade deficit as imports grew more rapidly than any response from exports (Bashford 1987, Datt 1987a:24, Kabra et al 1987:155, Lucas 1988, Nayyar 1988, Hindu 1989). As the deficit grew, the availability of foreign exchange constrained policy choices and helps to explain why there was a reversal of some import liberalisations in the late 1980s[40].

These new technologies have been associated with some outcomes that will improve company performance or alleviate industrial and technological constraints. Significant improvements in productivity have been recorded (though limited by long learning curves and poor managerial skills) and so have improvements in output quality.

In chapters 3 and 4, Indian software production was described as being low on skill-, capital- and technology-intensity. Lack of available hardware was 'the biggest impediment *currently being faced by the industry*' (*Khanna 1984*)[41] and import liberalisation was a necessary step to alter this situation and to allow an increase in offshore working. However, there was little impact on the form of exports until other factors came into play to persuade and allow companies to use imported hardware for software exports rather than just domestic leasing.

While entry barriers have been raised thanks to greater skill- and capital-intensity of new technology, they have been lowered by technical changes which have offered cheaper, more portable technologies. In the short term, the Indian software industry is benefiting from the skill shortages and high payments that 4GLs are creating in overseas markets, and from a reduction in the growth of the gap between supply and demand for software labour within India.

Nevertheless, there are problems associated with these new technologies, particularly new software tools. For example, they promote greater reliance on the interactional, analytical software production skills which the Indian industry has least of. In the long term, the impact could be devastating for the current style of Indian software exports. Growing

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[40] 'The import bill went up and the liberal policies were gradually made more restrictive.' (Dataquest 1988b).
[41] A point also made by Cleetus (1984b) and Raman (1985).

automation is likely to erode India's competitive cost advantage, reduce the amount of contracting out and, ultimately, remove the need for most of the current type of software development jobs, with the lower-skilled jobs disappearing first. As noted in chapter 4, India's particular form of software exports is therefore particularly vulnerable to growing use of new technology.

4. Alternatives to import liberalisation

Whether or not one wishes to praise import liberalisation, it is pertinent to ask - did the Indian government have any alternative but to liberalise imports of software tools and hardware in the mid-1980s? It seems that for software tools, it did not, but that there was greater room for manoeuvre with hardware policy.

4.1. Software tools

Because it was technically and bureaucratically impossible to introduce a policy which differentiated between software tools and software products, the question for 1986 became - is there any alternative but to liberalise imports of software?

As an intangible, easily-copied technology which resides on small, inexpensive media, software is highly susceptible to both piracy and smuggling (via mail or telecommunications), which allows circumvention of any protectionist policies. Before the spread of microcomputers in India, a policy of software import protection was viable because minicomputer and mainframe software is much harder to pirate or smuggle, and because consumption levels were low enough to make licensing of imports and reliance on local sourcing of other software feasible. Once PCs came on the scene, for which software packages rather than custom software are the norm, then piracy or smuggling became an easy option[42].

Had protection remained, it would have saved foreign exchange but it would have hampered uptake of software tool technology which has helped to earn foreign exchange. Protection would have assisted the growth of local software producers, but the attendant piracy would have stunted that growth even more than it has already done (as described in chapter 4).

There would have been growing international and local pressure to clamp down on piracy (and probable retaliation against Indian software exports); distributors would not have come to India which would have been denied access to the training, support and technical

[42] And a necessary one for users who could not wait months before making use of their PC.

updates they provide; and the growing ranks of minicomputer and mainframe users would have been penalised because they would have had to continue obtaining government permission for all their software imports, being unable to use piracy.

Software import protection would also have been bureaucratically burdensome and have faced great antipathy from all user groups and others. In chapter 9, it will be seen that there were strong political pressures from within the software industry and the government and weaker pressures from foreign governments and companies, all in favour of liberalisation. Only the few local software package producers dissented.

For software exporters, protection would have made it harder to gain 4GL skills, harder to compete for the growing market of 4GL-based work, and even more likely that they undertake onsite rather than offshore work. Yet, they would still have been subject to the potentially negative 4GL impacts on jobs, contracting out, competitive advantage and skills.

Thus, while there might have been theoretical alternatives to software import liberalisation in 1986, there were no really practical ones given the nature of the technology, the industry and its markets, particularly its export bias.

4.2. Hardware

Hardware imports not specifically related to the software industry were liberalised quite substantially in 1984. Because it is a radically different technology, hardware cannot be pirated as software can. Smuggling does take place, though more for components than whole computers (Dataquest 1984c, GoI 1987e) and in the latter case it has been restricted to a few PCs.

Local firms were producing all three main types of computer prior to 1984 and they lobbied hard against any import liberalisation, arguing that they could supply the market. However, the Prime Minister was in sympathy with the wishes of computer consumers rather than producers and it was his personal influence which pushed through the changes to import policy (Seshagiri 1988:35).

Given the circumstances, there were alternatives to the degree of hardware import liberalisation undertaken in 1984. It is not possible to evaluate all the 'What ifs', but the findings described in chapter 6 suggest that import liberalisation was taken too far at that time, and the realisation of this partly explains the reversals of liberalisation which occurred in the late 1980s. A lower level of liberalisation would have saved foreign exchange and been less damaging to the capabilities of an already well-established Indian hardware industry.

As regards the separate policy on hardware imports for software exporters, there are many policy alternatives that could have been chosen but few that would have been practical. Much of the liberalisation that occurred was of procedures and there are no real arguments against this. Loans and other liberalisations all helped to ensure that software exporters got access to the hardware necessary for offshore work. While some use these machines for domestic leasing, export obligations should ensure that India does not lose money through these imports, and the relatively small number of computers involved and their large size does not present too much of a threat to the local hardware industry.

4.3. Summary

The issue of alternatives to existing policies is a very contentious one, in which there are few certainties. It is argued that there were no real alternatives to software import liberalisation in 1986 or to the (more limited) liberalisation of hardware import for software exporters since 1984. However, there were viable alternatives to general hardware import liberalisation; a point taken up in the next chapter.

5. Conclusions

Import policy on technology imports of relevance to the Indian software industry was liberalised during the middle years of the 1980s, changing implementation as well as import duties and licensing rules. In the years following the policy changes, the import and use of technology rose significantly. However, the observed impacts are the result of a combination of a number of factors. Import liberalisation has played a necessary, but only partial role in increasing access and use. While it helps to open the channel for technology usage, thus indirectly stimulating that use, it does not provide the explanation for increasing levels of use.

Complementary inputs - awareness, skills, finance, legal protection - are all required before new technologies can be introduced and import liberalisation alone does not address these problems. Nor, as seen in chapter 6, does it address the problem that imports compete directly with local sources of supply. In chapter 8, the positive role that government interventions may have to play in these complementary issues will be discussed.

For its export-related use of software tools, India is entirely dependent on foreign suppliers, though the dangers of this dependency need to be set against the early provision of awareness and skills with which these suppliers have been associated. This balance of costs and benefits within links to foreign companies will be investigated in greater detail in chapter 7.

Import liberalisation has had a positive impact on the available technology. In a fairly direct way it has helped reduce prices and technological lags of imported technologies, and it has indirectly assisted the same process for locally-produced hardware. However, in the latter case, government demand interventions, user demand, and extrinsic technological factors have been much more important in explaining price and technology improvements, and these have both relied on the presence of a local industry with a sound base of technological capabilities. The negative impact of devaluation in this case reinforces the need for both co-ordination and specificity in government policy.

There is a positive association between import liberalisation and increasing use of these new technologies but skills availability, technical changes, external market demands and other issues associated with offshore production decisions are much stronger elements in any explanation of the increased use.

There have been several outcomes of this increased use and it is fair to say that import liberalisation has been a necessary though not causal factor in overcoming technological constraints for Indian software exports. It has also proven the validity of the 'flood in, flood out' concept because the imports of new technology have helped improve productivity and quality of software production and provided access to growing global markets, thus increasing the level of software exports. The inability to restrict import liberalisation to software exporters alone has, however, meant that in overall terms this policy change has been associated with such a growth in the balance of trade deficit that a policy reversal towards greater protectionism resulted after a few years. This illustrates the limitations of 'flood in, flood out'.

And, while in the short term new software tools may lead to an additional demand for programming skills from India, in the medium term they will require a difficult upskilling of the Indian workforce and, in the longer term, will present a substantial threat to India's particular form of software exports as production becomes increasingly automated with the increasing use of case tools.

In chapter 1, some elements of the outward-looking trade model were described, including the idea that free trade policies would lead world trade to fall into line with various national comparative advantages. The Indian software industry clearly has such a comparative advantage, yet import liberalisation and export orientation are allowing it to be forced by market demands to be increasingly uncompetitive in relative terms.

Yet these potential problems should not be seen as the basis of a call for increased import protectionism for software tools. At least for exporters, they need to take advantage of the benefits the tools can bring now, before the threats increase. In any case, policy choices have been constrained and determined by factors of political economy and by the nature of the technology. The unusual nature of software meant that the government had little choice but to liberalise imports, though this reinforces the need for a policy which is sensitive to the requirements of different industrial technologies.

Hardware import liberalisation has also helped to raise the balance of trade deficit, but has been associated with few consumption-related threats or problems. However, as will be seen in chapter 6, it has threatened the growth and capabilities of hardware production within India.

CHAPTER 6

IMPORTS AND PRODUCERS

Introduction

In chapter 5, the relationship between import liberalisation and Indian consumers of new technology was considered. In this chapter, the relationship between import liberalisation and Indian producers of new technology will be considered. The balance of policy focus between consumption and production was outlined in chapter 2, with the focus and objectives of hardware policy shifting decisively from production to consumption during the 1980s[1]. As Mahalingam (1989) points out, choice of policy strategy, especially import policy strategy, will depend on the perceived relative importance of consumption and production.

In this chapter it will be argued that import liberalisation cannot be regarded as the optimum strategy for those countries wishing to develop local production capabilities and that some measure of import protection has to be in place for this development to take place. However, the case is made for a reactive government policy which can apply varying degrees of protection or liberalisation as the circumstances of external change and industrial development demand. Therefore, both the timing and phasing of policy changes can be important. As in the previous chapter, technical change and other factors will be shown to have mediated some outcomes and to have constrained policy choices.

Two principal imports were highlighted in the previous chapter - software tools and hardware. Production of both will be considered here. Although the thesis question focuses on the Indian software industry, software policy contains many hardware-related measures which have affected the Indian hardware industry's development, necessitating a study of the latter. Issues relating to imports and local production are also very usefully addressed by reference to the hardware industry because of its long history and the different policies it has been subject to during that history[2]. These have already been described in chapter 2 and will not be repeated in any great detail.

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1 A point also seen in Dataquest (1989e).

2 The close relationship between hardware and software, with hardware being a vital part of software development and software being a vital part of any computer system, reinforces the need to consider hardware when looking at software.

The key year for software imports is 1986, when imports were delicensed, and policy after that time has remained fairly static. The situation for the Indian hardware industry was more complex, and four periods can be distinguished:
i. Openness to foreign imports until 1972;
ii. Protection from imports until 1984 (though with slight liberalisation in 1983);
iii. In 1984, import policy on complete computers, computer kits and components was substantially liberalised, though never completely liberal;
iv. From 1987 onwards these liberalisations were reversed so that import policy in 1990 was a compromise between the relative extremes of mid-'70s protectionism and mid-'80s liberalisation.

Measuring industrial development

In order to chart the changes in local production capability, one needs some guides or measures. As in chapter 3, the two principal quantitative measures are level of overall production and level of exports but it will again be useful to look behind these measures at more qualitative data. Lall (1987:232) identifies 'technological capability' as a crucial determinant of industrialisation, yet one which is ignored by many quantitative-oriented researchers. Although this does not lend itself to outright measurement, some kind of scale can be drawn up for the technological capability of producers, as shown in figure 6.1[3].

Following Lall (1987:2-3), one may define technological capability as the general ability to undertake the broad range of tasks outlined in the table, and technological development as growth in the capability as defined by movement up the categories and regardless of whether or not the final stage is attained.

These capabilities are actually embodied in the skills and experience of individual workers, often seen as the most critical resource for information technology industries (O'Connor 1985, Kumar 1988). In this case, technological development will be the accumulation of increasingly skilled workers.

[3] One could set out a much finer scale with dozens of increments. For example, it is arguable that process innovation requires a greater level of capability than product innovation. Nor is the scale completely comprehensive; it does not exactly suit unusual technologies like software.

Figure 6.1

Scale of producer technological capability

1. Choice and use
- Choosing the technology
- Setting the environment for use of the technology
- Using the technology

2. Adaptation without production
- Product modification to meet local needs
- Minor product innovation to meet local needs

3. Basic production
- Copying technology
- Assembling technology
- Full production using existing products and processes

4. Inward-looking skilled production
- Product or process modification to meet local needs
- Product or process redesign to meet local needs
- Product or process innovation to meet local needs

5. Outward-looking skilled production
- Product or process modification to meet regional/global needs
- Product or process redesign to meet regional/global needs
- Product or process innovation to meet regional/global needs

6. Global production competing through innovation
- Major product or process innovation to meet global needs
- Transfer of technology to other users and producers

Source: Adapted from Narasimhan (1984:2-3), Lall (1987:13-19) and Schmitz & Hewitt (1989).

1. Software package production and import liberalisation

In this section, the development of software package (both tools and applications) production within India will be reviewed as well as the impact of import liberalisation on this development.

1.1. Quantitative changes in software package production

There are no accurate figures on software package production in India. By summing the package revenue of some of the leading producers and using figures provided by Dataquest (1990w), one can estimate that software package production grew by about 40% per year in rupee terms between 1986/87 and 1989/90 and that total production (domestic and export sales) in 1989/90 was probably somewhere between US$3m-5m, of which exports made up just over US$0.5m. Imports of software packages are likely to be at least an order of magnitude greater than total Indian production.

1.2. Qualitative changes in software package production

At first sight, the Indian software industry in 1990 would appear to have a strong base of software package production capabilities, with local companies producing a wide range of software including accounting and word processing packages, databases, fourth generation software tools and specialist programs[4]. To take the example of software tools, at least five companies are marketing such tools that they themselves have written and several other software companies have their own in-house software tools which are used for contract work done within India.

Competition with imports

Closer examination reveals that the situation has changed over the past few years. All of the marketed tools were created prior to 1986, when software imports were liberalised. Since then, most local companies have been unwilling to invest in development of products which would have to compete with imported tools. One company director commented

> "At first, we were alone in the marketplace, but now things are so crowded with foreign-made products that there is nothing to be made in producing and marketing our own tools and we are focusing our efforts elsewhere."

A second change has been that software tools (and other application software) are becoming ever more complex and involve ever increasing development costs. This and other international trends (see Gaio 1989:159-60) make it increasingly difficult for Indian companies to enter software package production.

Both increasing complexity and importation have compounded other difficulties for Indian producers. The software import tariff compensates Indian companies for the scale economies which they cannot achieve but which multinational software producers can. However, Indian companies have to compete not just on price but also against a strong preference for foreign-branded software among Indian consumers (Polavarapu 1989e, Pawar 1989:E25)[5] and against all the other constraints described in chapter 4, including

[4] See, for example, Dataquest (1990r).

[5] Verghese (1986) and GoI (1987e) also highlight the preference for foreign IT goods.

piracy. Given these factors, it is not surprising that a number of firms have abandoned commercial package production in the late 1980s.

The marketed tools created prior to 1986 generally developed from software tools made by staff working on in-house projects, which were then reformed into a commercially acceptable product[6]. The initial capability stage of this process was still found in the 1989 survey, because programmers do still create software tools for their own use. Improved access to imports, partly thanks to import liberalisation, has therefore suppressed the commercialisation of this capability in a marketable product rather than the capability itself.

Unfortunately, the capability too is under attack as the use of imported software tools spreads. While programmers were able to devise their own tools for use with third generation programming languages, 4GLs have become so flexible and all-encompassing that creation of in-house software tools has not been seen within 4GL-related work.

A similar pattern can be seen in relation to both systems and applications software. In the 1970s and early 1980s, most of this software was developed locally. For example, most Indian computer companies supplied their customers with operating systems they had written themselves. By the late 1980s, the great majority of such software was imported. Indian-produced micro- and minicomputers were supplied with the US-developed operating systems MS-DOS or Unix. Some hardware companies continued to develop their own operating systems but only in areas where global standards did not exist and where import competition was therefore not so strong, such as multi-user or multiprocessor operating systems (see section below on design innovators).

Kumar (1989b) therefore complains

> "The policy has clearly encouraged trading and imports rather than local R&D."

Post-Import Innovation

Despite the comments of the foregoing section, the figures quoted above indicated a strong growth in domestic package production in the years following software import liberalisation. This has occurred in three principal ways.

6 This has also been the route employed by most companies in the West which sell 4GLs (Thomas 1988).

1. Protected markets

Since 1986 many packages which have sold quite well (by Indian standards) have been India-specific applications such as Indian-language word processing; packages automating Indian accounting and banking practices; astrology and homeopathy packages. Such market niches are protected from imports not so much by continuing tariff protection but because they are too small, competitive and unprofitable, and because they require too high a level of local knowledge for foreign companies to wish to exploit them.

Some companies are selling specialist software products such as program generators, anti-virus and anti-piracy programs, which are not India-specific and for which foreign analogues exist which could potentially compete. But, as before, the markets and profits are seen as too small to justify the costs of linking up with a foreign supplier and then marketing the foreign product, particularly when import tariffs have to be paid.

In many of these companies, the product has been developed from scratch and developed in-house. Initial development work is often done either as the spare-time project of one of the programmers or as a custom software assignment for a local client. In either case, the software company is largely able to ignore the cost of such development and only seek to recoup the costs of commercialisation and marketing. Because of this the company is able to meet the market demand for very low prices.

2. Reverse functional engineering

Indian companies selling their own products like word processors, databases, spreadsheets and compilers are competing directly with foreign imports. Such products are usually written by the process of 'reverse functional engineering' (RFE).

Normal reverse engineering of a product requires that it should be taken apart in order to see how it works and is put together. Many Indian software companies attempt to do this with imported software but usually find themselves unable to access the program source code[7]. They therefore have to rely on discovering what the software does (i.e. what its functions are) and then imitating these by writing their own programs.

This is a skilled operation, requiring analysis of the imported software's functions, followed by local design, coding and testing. During this process Indian companies frequently add some extra features to the software (possibly geared to local conditions) or

[7] Source code consists of the original lines of programming language code that make up a program. Before they are marketed, most packages have their source 'compiled' into 'object code' which cannot be altered or reverse engineered.

develop code routines which improve on the performance of the original (Ghosh 1988b). Because they are able to avoid the extensive market research and user testing of the original producer, and because of the relatively low software production costs in India, such products are able to compete against legal imports on price[8] and, to a lesser extent on features and performance. However, there are also signs that local packages compete because local companies agree to customise them for users (Ghosh 1988b).

While it may create skills, capability, and minor innovations, reverse functional engineering is dependent on following overseas trends and major innovations. But, with a steadily advancing technological frontier in software, India's position as a 'technology follower' may still be regarded as a positive development.

As Narasimhan (1984:11) and Bagchi (1988:74) point out, self-reliance should not be confused with self-sufficiency, and a nation may be seen as self-reliant if it is able to 'import, adapt, and absorb the technologies that are needed at the time they are needed', which is what RFE entails.

There are two dangers for the Indian industry in this approach. Firstly, as software becomes increasingly complex, with the addition of extra features and non-textual interfaces, it will become harder for Indian companies to write code mimicking its functions.

A greater danger is that this path of local software development has been dependent on lax application of copyright and patent rules (Gaio 1989:247-50). The success of Lotus Development Corporation in suing Paperback Software in the US (Schofield 1990a) means that prosecutions can be launched on the basis that one company's software product copies just the 'look and feel' of another company's earlier product.

Indian companies which employ reverse functional engineering of imported products have relied for much of their success on the fact that they get as close as they can to the 'look and feel' of that imported product. If US companies are successfully able to pursue similar prosecutions outside North America, the reverse functional engineering path may be closed to Indian developers. As the Indian domestic market grows, such prosecutions become increasingly likely.

[8] Software produced by reverse functional engineering is priced at about one-third the price of equivalent imported software (including tariff). See, for example, Dataquest (1990w).

3. General factors

The major market for software within India was created because of the boom in computer sales, which was aided partly by hardware import liberalisation. With the demand for software largely being met by piracy, there was little alternative for the government but to liberalise imports. Since the mid-1980s, piracy has decreased, partly due to the actions of Indian software distributors out of self-interest and at the behest of foreign suppliers[9].

Indian software package producers have therefore been increasingly able to change their marketing tack from competing with pirated software to competing with legal imports. This has benefited them because their products were more costly than pirated software but cheaper than legal imports. Thus, in a rather roundabout way, import liberalisation has helped the development of a local software package production capability.

Exports

The export of software packages from India has already been discussed in chapters 3 and 4. In 1989/90, such exports formed just over half of one per cent of gross software exports from India (Dataquest 1990w) and most of the exported packages were developed around specifications and designs created by an American or European company, leaving the Indian 'producer' to do only the coding and testing rather than any substantial innovation. The constraints within both the global and domestic software markets that hamper software package exports from India have already been noted - rapid pace of technical change, distance from markets, high investment costs, and bias to existing foreign producers.

The difficulty for Indian software package producers of competing in export markets forms the basis of the argument for import protection because local producers lack the scale economies of foreign producers, who are not confined to the Indian market (see also ESC 1988:41).

1.3. Summary and conclusions

> "Importing technology, and generating technology domestically, are usually not mutually exclusive alternatives" (Fransman 1986:72)

[9] For example, Tata Unisys Ltd was encouraged by the US company Microsoft to persuade Indian hardware companies, through a mixture of carrot and stick, to supply legal rather than pirated copies of the MS-DOS operating system with their computers.

This is clearly the case for software package development in India. Imports have been liberalised but the output of local producers continues to rise, and innovations take place. Indeed, by indirectly attacking piracy and increasing overall demand, imports have stimulated local software package production. Thanks to reverse functional engineering, imports have also stimulated such production and also the acquisition of minor production innovation capabilities.

However, RFE is a pattern of production that is increasingly under threat and imports now dominate the Indian domestic market. Thus, rather than impelling Indian producers to greater efficiency, import liberalisation has eaten into their already small markets; reduced their ability to take advantage of any economies of scale; made them less likely to invest (Singh & Ghosh 1988); and caused some to abandon software package development altogether. Most of India's software production capabilities continue to exist only where they do not come into commercial competition with imports, in niche or India-specific package markets or in software services.

Equating import liberalisation with increased access to imported software[10], one may conclude that, although it may have been a necessity and have developed some minor innovation capabilities, import liberalisation has helped to stifle other capabilities and development opportunities. There is therefore some support for Kumar's (1987) argument that 'government protection is crucial for the survival of this industry in India.'

It has been important for the protection of Indian software capabilities that while software package production has to compete with imports, local software services do not, because of the high cost and lack of local knowledge of foreign software services companies. It is services - custom development, in-house and spare-time work - which remain a major source of software capabilities feeding into software package development.

The close interaction of software services and products arises from the particular technological form that software takes. Other aspects of this form allow software piracy to take place and it must be recognised that piracy has reduced investment, innovation and technological development in Indian software package production.

The extent of government intervention on piracy represents the balance of concerns between consumption and production. Governments concerned only about the former have no desire to do anything about piracy. For those which grow more concerned with production, piracy has to be dealt with through legislation. Unless and until piracy can be

[10] As described in chapter 5, this is only a partial equation.

fully dealt with, there will be few alternatives to import liberalisation, and software package production - at least of horizontal (rather than niche) market products - will not be a good entry point into the IT and software industries.

As will be discussed in chapter 8, there are grounds for action by the Indian government to increase demand for local software[11] rather than buying imported packages as it has tended to do (Ghosh 1988b); to stimulate software research and development; and to help reduce some of the barriers to software package exports.

> "Otherwise ... India will be confined, as it is presently, to importing high-value added software in exchange for exports of low-value added software." (Lakha 1990)

2. Hardware production and import liberalisation

In this section, the development of hardware production will be reviewed, as well as the impact of import liberalisation on this development. Hardware will be taken as being synonymous with 'computer' and not to include other goods such as peripherals (disk drives, monitors, keyboards) and components (printed circuit boards, microprocessors), though the latter will be referred to.

2.1. Quantitative changes in hardware production

Growth of local hardware production

Table 6.1 shows the rapid growth of computer production in India[12].

[11] As, for example, the Brazilian government has done (Correa 1985:51).

[12] The figures from 1981-87 include a correcting factor because the published statistics also include the value of peripherals produced, which makes up 10-15% of total hardware production. Figures exclude production for export. The contribution of computer manufacture to overall electronics and industrial production has more than doubled during the 1980s (DoE annual reports, Shekhar 1988).

Table 6.1

Computer production in India

Year	Number of computers	Value (Rs.m)	Value (US$m)	Growth rate in rupee terms
1981	800	330	38	
1982	1200	430	45	30%
1983	1300	700	69	63%
1984	3400	830	72	19%
1985	7200	1400	115	69%
1986	c.25,000	2500	200	79%
1987	c.40,000	3200	250	28%
1988/89	c.55,000	5000	340	(56%)
1989/90	c.83,000	7000	440	67%

Source: DoE annual reports, Shekhar (1988), Dataquest (1989l) and Dataquest (1990w).

The strength of local production can also be measured relative to imports of computers. Table 6.2 shows the ratio of domestic production to computer imports[13].

Table 6.2

Ratio of Indian domestic computer production:computer imports

Year	Ratio
1981	2.1
1982	1.8
1983	3.8
1984	1.0
1985	0.9
1986	1.3
1987	4.4
1988/89	2.3
1989/90	6.9

In the early 1980s, local producers serviced the major part of the local market and growth rates were moderate. In the mid-1980s, local production grew rapidly but imports grew even faster so that the large growth in demand was at first met largely by imports, which took the major share of the market in 1985. In 1987, there were falls in both imports and production growth as government investments and foreign exchange were diverted into higher priority areas because of the drought. By the end of the 1980s, local

[13] The figure for 1988/89 uses the 1988 figure for imports (given in chapter 5).

production was still growing very strongly[14] and had re-asserted itself over imports as the prime source of computers for Indian consumers, making up over 85% of domestic consumption.

Indian computer industry growth is dependent on a number of factors including industrial licensing, overall demand, access to inputs, marketing, prices, technological lag, technological standardisation, and attitudes towards computers in the private sector. Market share is determined by the relative attributes of price, technological lag, quality, accessibility and desirability of either imports or domestically-produced computers.

As seen in chapter 5, import liberalisation has had a partial impact on some of these factors. To summarise this impact, while import liberalisation of kits, peripherals and components has favoured the growth in local computer production, the liberalisation of imports of complete computers has reduced the market share of local producers, as suggested by the figures above.

The rise and fall of market share corresponds to changes in import policy. The market share for local production dropped following liberalisation in the mid-1980s but has risen in the late 1980s as the threshold for minimum configuration of imports and import duties were raised. With Indian firms unable to address a large market and so achieve large scale economies, continuing tariff protection has allowed them to compete with imports and achieve increasing import substitution.

Of course, import policy has not been the only instrument of the Indian government to affect the industry. For example, government helped to engineer the strong growth in India's computer industry through its demand policies.

Growth of local component production

The figures presented above tell by no means the whole story because much of the computer production within India is not as 'local' as it might appear. Statistics are hard to come by but those of GoI (1987e), IDC (1987) and Shekhar (1988) suggest that the import content of Indian computers fell by more than 20% between 1982 and 1984, but then rose by over 40% between 1984 and 1987.

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[14] In 1989/90, rupee turnover of the two largest hardware companies, HCL and WITL, grew by 53.4% and 26.7%. Such has been the expectation of high growth that these rates were respectively described as 'relatively good' and 'meagre' (Dataquest 1990w).

By this point, about 80% of the cost of components and materials for Indian computers was made up from direct imports[15]. Much of the remaining 20% of components were bought from Indian suppliers but themselves had a high import content. There were some possible signs of recovery after 1987, with the component industry registering an average annual growth rate (in rupee terms) of 43% between 1987 and 1989, compared to 26% between 1981 and 1987 (GoI 1987e, GoI 1989a, India Today 1990).

In 1984, government policy helped fuel a large increase in demand for computers. Coupled with import liberalisation of complete computers, this led to a large proportion of that demand being met by imports. However, one type of computer - the microcomputer - remained protected, so that companies wishing to respond to demand had to produce them locally and they therefore sought components for these PCs. A number of factors led to the growth in local demand for components being met largely from imports.

Firstly, import liberalisation allowed relatively quick and cheap access to imported components.

There were also technical factors, particularly the emergence of the IBM-compatible PC as a copiable global standard, which Jaikumar & Krishna (1987) cite as 'the single most important factor of change' affecting the Indian industry. Despite certain protective measures and because of a lack of litigation, IBM found that its computer was being reverse engineered by other companies which then produced microcomputers which were compatible with those of IBM and which were invariably cheaper. This helped the IBM PC to emerge as a stable and standard technology.

This computer was technically relatively simple in the first place. As it became a stable standard, subsequent technical progress centred around making the same computer with fewer parts. This simplicity enabled companies in South-East Asia to produce PC kits which could easily be assembled into a computer. This greatly reduced both the skill and capital barriers associated with hardware 'production'. Standardisation of the operating system software also allowed hardware producers to avoid needing any software skills.

Thirdly, many Indian companies which wanted to move into PC production were trading companies (GoI 1987e). They had no background of technical or manufacturing skills and therefore kit assembly was all they were capable of. At least at first, they could not think of trying to integrate imported and local components.

[15] This cost figure includes import duties. See also GoI (1987d).

Finally, and despite the increasing local content of computers up to 1984, the Indian component industry was in a rather poor state at that time. It was characterised by high costs, poor quality, outdated equipment, lack of skilled staff, and lack of research and development. All this left local component producers unable to respond adequately to the growth in demand (GoI 1987e).

With local computer producers turning to imports, this further weakened the growth opportunities for the local component industry (GoI 1987e, IDC 1987, Shekhar 1988). Only once liberalisations were reversed after 1987 did the local component industry show any signs of recovery.

Given the past and likely future state of computer technology and component production, India cannot hope to be self-sufficient as regards computer components[16]. Many components, including the central processor, require too high an investment, scale of production and risk for their production to be a viable aim for India[17]. Such components can only be imported and so, for these, import liberalisation is the best policy option.

The same cannot be said of other components (such as memory chips and specialised processors) and sub-assemblies such as peripherals and computer kits, which can be produced by the Indian component industry. In this case, there are alternatives to import liberalisation, but policy making is caught in the conflict between component consumers (such as the computer industry) who favour imports and component producers who want to be protected while they build up their production capabilities (EIU 1986:103, GoI 1987e).

Computer exports

The level of computer exports from India is shown in table 6.3[18].

[16] A similar point is made by Hutnik (1988b).

[17] See Mody (1985), O'Connor (1985), Dataquest (1987), Dataquest (1988i) and Mahalingam (1989). These authors point out that most developed countries, except for the US and Japan, have found it very hard or impossible to sustain a microprocessor design and manufacture capability. For example, whereas Intel's first microprocessor, the 4004, cost US$60,000 to develop in 1970, its i486 chip cost US$500m in the late '80s (PCW 1990).

[18] Figures are difficult to obtain because most published figures for hardware exports include both complete computers and peripherals, of which the latter form the major part (Financial Express 1989).

Table 6.3

Gross Indian computer export earnings

Year	Exports (US$m)
1981	0.2
1982	0.2
1983	-
1984	0.8
1985	2.0
1986	1.6
1987	2.2
1988	11.4
1989/90	30.7

Source: Estimates by DoE officials, IDC (1988b) and Dataquest (1990w).

Computer exports grew very rapidly at the end of the 1980s, which may present an indication of the growing strength of Indian computer production, since exports can be a sign of production efficiency and/or innovation. Exports can also provide the necessary economies of scale to allow globally competitive production.

In reality, though, most of India's computer exports have been basic PCs, which are assembled in India and have a very high import content. They have little local value added, make little positive contribution to India's balance of trade (Polavarapu 1988, Dataquest 1990q, Raina 1990), and require little technical knowledge to produce. They rely on low labour costs rather than efficiency or innovation to gain a place in the export market.

The stability of basic PC technology has been important because only where technologies are relatively stable, and where product cycles are mature can developing countries hope to compete on cost (Cline 1987:23-24, Evans & Tigre 1989). Where technical change is rapid, as it is for more powerful hardware or for some types of software package, reliance on low labour costs will not be enough.

The destination of India's hardware exports provides further evidence that export performance is not a good guide to technological capability or even efficiency. The majority of such exports go to the USSR or other former Eastern bloc countries under bilateral trading agreements, and are paid for in rupees (Polavarapu 1988, Raina 1990). Since the Indian companies have to pay for the kits or components in foreign exchange, these exports cause India a substantial foreign exchange loss. The exports rely on this for *their success - the Eastern European* countries buy the computers from India only because it avoids the necessity to spend hard currency for new technology. Therefore, Indian firms do not have to be efficient or price competitive to win such orders.

As the Eastern European economies are drawn into the international capitalist economic order, such bilateral agreements may be dropped and so, too, may these exports. In any case, the Indian government has expressed increasing concern and dissatisfaction with these exports and, in 1990, was considering insisting that exporters match all rupee payment exports with equivalent hard currency exports (Dataquest 1990q).

There is another side to Indian computer exports - those which are basic technology but which compete on price (Dataquest 1990w), and those which are innovative (Darshini 1989a, Dataquest 1990a, Dataquest 1990e, Dataquest 1990w). These only represent a small part of overall exports and sales of both types have not grown as expected because of market barriers (Polavarapu 1988, Raina 1990).

As mentioned here and in chapter 5, scale of production is an import factor determining production costs and price. A globally competitive scale of production for basic PCs is around 50-100,000 computers per year (Cline 1987:27-28). But, with a relatively small yet strongly competitive domestic market and with US and South-East Asian domination of PC export markets, Indian firms cannot sell in anything like such high volumes[19]. This keeps prices high which, in turn, reinforces the difficulty of selling in high volumes (Polavarapu 1988, Mahalingam 1989). As with software packages, the difficulty of achieving the scale economies available to foreign producers is one reason underlying the continuing tariff protection on imports[20].

Indian companies face further problems in the export market because computer sales depend on more than just price or innovation. With reliability and long-term support being vital to successful use of computers, company 'name' and reputation count for a great deal. For proof of this, one need look no further than the IBM PC which dominated microcomputer sales during the 1980s despite there being plenty of competitors producing cheaper and/or more technically advanced microcomputers.

Potential Indian exporters also find themselves hampered by a lack of marketing channels and market information; a lack of sources of finance; and an overburden of government licences and procedures (Polavarapu 1988, Malhotra 1989b, Raina 1990). The government has followed neo-liberal financial prescriptions by fully recompensing exporters for all import duties and by providing an additional export subsidy, but this has not been enough to overcome the problems listed.

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[19] In 1989/90, the largest Indian producer sold less than 12,000 microcomputers of various types (Dataquest 1990w).

[20] One danger of increasing innovative computer exports from India is that these may trigger foreign pressures on the Indian government to reduce computer import protection without opening up scale economies of production to the majority of local producers.

By 1990, Indian computer policy showed signs of changing away from its historical concern with import substitution alone, towards a greater acceptance of the importance of export markets. Just as it was argued that the Indian government needed to refocus its software strategy to balance exports and domestic-oriented production, so it is with hardware policy. The export performance of a few Indian firms indicates that the export barriers are not unsurmountable, but they are great for most firms and they would appear to need to be addressed by a mixture of both liberalisation and intervention from government.

As regards import liberalisation itself, the liberalisation of import procedures has helped exporters get access to necessary inputs more easily but, thanks to the 'duty drawback' provision, they are insulated from changes in import tariffs.

Summary and conclusions

Drawing conclusions from the data presented above is not easy. Many different factors have played a role - both demand and supply policies, technical and global macroeconomic factors. At the same time, there are hidden complexities behind the apparently simple facade of both import liberalisation policy and industrial performance statistics. A high *level* of exports, for example, is no indicator of an industry's capabilities, efficiency or even competitiveness.

What the data does suggest - to be expected when import liberalisation is introduced into an import-substituting industry - is that liberalisation of industrial inputs helps the industry to grow, but liberalisation of directly competing goods does not. At least partly as a consequence of import liberalisation, the great majority of the hundreds of millions of US dollars spent on computers in the wake of the Indian government's 1984 computerisation thrust left the country - either directly or to foreign component suppliers.

Companies complained about the harm done to them by competition from liberalised imports (EIU 1986:102, Kumar 1988) and the government itself recognised this, with a 1987 discussion paper (GoI 1987d) arguing for greater protection which 'may show reduced growth rates, since a lot of unhealthy growth will have to be pruned to allow slower, but healthier and more sound progress'. As a result, some of the earlier import liberalisations were partly reversed, though kit assembly still continued.

India cannot hope to be self-sufficient in new technology. Production of some technologies - supercomputers, microprocessors - is beyond its means and there is a recognition of this in the differentiated import policy, which allows such imports much lower rates of protection than items which can be produced in India. For the latter, there are scale economy arguments to justify import protection, as well as arguments about building capabilities which will be discussed below.

Government policy stretches beyond import controls and duties. Policies to increase demand and to liberalise industrial licensing and capacity controls (see chapter 4) have helped to increase local production. Exports have been assisted by financial incentives, though they need more than this to further reduce the bureaucratic burden on exporters and to address supply-side constraints. At the end of the 1980s, there was a recognition of this within government policy and some attempt to redress the balance between exports and domestic-oriented production. Nevertheless, Indian computer exporters, like their software package counterparts, face some formidable external barriers and constraints, particularly as their major export market may soon disappear.

2.2. Qualitative changes in hardware production

In the previous section, the relationship between import liberalisation and overt measures of industrial development was assessed. Although this relationship was better understood through qualitative data, little mention was made of a crucial qualitative factor - technological capability. In this section, the development of the Indian computer industry's technological capability and its links with government policy will be assessed.

This section will focus mainly on the period since liberalisation of computer industry licensing in 1978, but it is worth briefly reviewing what preceded this[21]. During the 1960s and early 1970s, multinational companies were allowed virtually free rein in the Indian computer market with the result that the market was supplied with outdated equipment that was all imported. Because India had no local base of computing skills, the Indian government had little choice but to agree to this situation.

However, as familiarity with the use and maintenance of such equipment grew and as skills developed in complementary areas of electronics, the government felt confident to alter policy and severely restrict imports in order to encourage indigenous production. Production-related capabilities including design and manufacture were built up within India but these remained confined to one public sector firm (ECIL) until industrial licensing was liberalised in 1978, from which point a number of private sector computer producers emerged.

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[21] For further details see Chapter 2, Grieco (1982) and Grieco (1984).

By the end of the 1980s, one could identify three principal types of computer producer within India.

I. Assemblers

These are companies which import the component parts of a computer, assemble them in India and then sell the unit under their own name.

In terms of company numbers, such firms made up by far the majority of the Indian computer industry at the end of the 1980s (Jaikumar & Hutnik 1988, Bhagnari & Polavarapu 1989, Bagchi 1990) but they were mainly restricted to making bottom-of-the-range PCs. They typically have a very low scale of production, assembling only a handful of PCs per month. However, because there are several hundred such firms and because some larger firms are also assemblers, they supply a large proportion of the domestic PC market and most of India's computer exports (Ribiero 1988b, Bhagnari & Polavarapu 1989, Dataquest 1989r).

Almost all of these firms have come into existence since the 1984 computer policy and they owe their existence to two principal factors. Firstly, the technical features and developments associated with the IBM PC, which were described above.

> "Since the products are in the standardized form with no great technological challenges, it is easier for many to set up shop." (Bhagnari & Polavarapu 1989)

Related to technical standards and simplicity, the low cost of kits or components and ability to hand-assemble these computers has further reduced production entry barriers.

Secondly, Indian assemblers owe their existence to the liberalisation of import legislation which allowed such kits or component parts to be imported relatively easily and cheaply. However, they also owe their existence to the continued protection which prevented open import of complete PCs.

Because there are scale economies in the production of microcomputers, these companies have to cut costs wherever possible in order to compete. Most hand-assemble the computers using low-paid, low-skilled workers and so avoid high production costs. They rely on sales to their local area to avoid high marketing costs and they do no research and development work[22].

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[22] GoI (1987e) also discusses the work of assembly firms.

However, it would be wrong to see assemblers as devoid of technological capability. In fact, there is quite a range of capabilities within this group. At worst, the computer will be imported as a semi-knocked-down kit from Singapore, assembled in less than half an hour using a screwdriver, and then sold. Most of the companies are of this type. At best, the various components (processor, monitor, disk drives, keyboard, casings) will be sourced from different suppliers, possibly including some local ones. Assembly then consists of 'component insertion, flow soldering and limited functional testing.' (Jaikumar & Hutnik 1988).

In either case, the capabilities are greater than those of trading companies and it is possible that assembly can form the base on which companies build up to higher capability levels.

II. Design Innovators

Assembly companies do not have a design capability, whereas this group of companies does, and they use this to undertake a range of product innovations. They also produce their own computers.

Most design innovation companies are long-established[23]. In the late 1970s and early 1980s, the Indian computer companies which dominated the microcomputer and minicomputer markets - including Hindustan Computers Ltd (HCL), Delhi Cloth Mills Data Processing (DCM DP), Operations Research Group (ORG) and Wipro Information Technology Ltd (WITL) - were undertaking design innovation production. That is to say, they designed the overall component layout for their computers' circuit boards and peripherals, then bought in components (such as processors) from foreign or local sources, put them together to make the computer, and then tested it. Locally produced operating systems, systems and applications software were then added to create a complete system[24].

However, in the mid-1980s, all this changed.

> "As a result of these policies, computer production in India has become largely an assembly operation, often from kits and is heavily dependent upon imported components and know how" (GoI 1987e)[25]

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[23] Most of the companies started microcomputer or minicomputer production in the years 1978-82, though start year in itself can be misleading because all the companies began by hiring staff who already had skills from previous work in other computer firms (see, for example, Devadas 1988).

[24] Details from interviews, Grieco (1982), Jaikumar & Hutnik (1988) and Malhotra (1988).

[25] The change to assembly production is also described by EPW (1984b), Bhatnagar (1986), GoI (1987d) and Jaikumar & Krishna (1987).

In the market for basic PCs, design innovators found themselves unable to compete with kit assemblers. They were forced to become kit assemblers themselves, often relying on foreign collaborations, as the General Manager of one of the largest producers, DCM DP, described:

> "We didn't have the necessary lead time to develop our own machines. It was a case of collaborate, or lose our market share in this crucial sector. I swung the Tandy deal for the company, but I still feel very sad at its necessity. We had the brains and the infrastructure to design and develop an Indian computer" (Pawar 1987a)

As well as the lack of development time, fierce competition in this market forced cost cutting. Production and research investments made in 1983 and 1984 were largely lost (Jaikumar & Hutnik 1988), profits were reduced, and R&D largely abandoned.

Some capable firms appear to have lost their design capabilities. Those which kept them could only afford to invest in R&D in areas of lower competition. R&D staff were therefore moved to work on more powerful computers based on the Intel 80286 and i386 and Motorola chips that came out around this time. Such computers were technically more complex than basic PCs, thus affording temporary protection from kit assemblers. At that time, there were few Indian computer companies with foreign collaborations producing powerful PCs, and the continued and subsequently rising level of import protection ensured the design innovators of sufficient profitability to justify their heavy R&D investments.

Design innovators also benefited from their existing base of capabilities, which allowed them to be accepted as 'beta-test' centres for new Intel and Motorola chips, enabling them to work on designs before the new chips were sold on the open market (Dataquest 1987c, Tandon et al 1990). Import liberalisation had a slight role in improving their access to these chips.

They were also assisted by a government committee decision. In 1985, the Rangarajan committee issued its recommendations for automation of Indian banks, including the recommendation that the computers to be used be based on the Unix rather than MS-DOS operating system (Economic Times 1985c, Tandon 1989b). Unix is more powerful than MS-DOS and needs a more powerful non-IBM-compatible computer to run it - such as those based on Motorola or Intel 80286 chips. This decision paved the way for a large potential market for Unix-based hardware, further encouraged R&D investment, and so helped to form the base for the hardware innovations of the late 1980s, many of which are Unix-based machines.

Two to three years after the import liberalisation decision, some (but not all) design innovators were therefore able to start re-asserting their skills in the market. HCL, WITL and DCM DP were all producing computers 'conceived, designed and developed entirely by their R&D' (Jaikumar & Hutnik 1988) and based on the latest Intel and Motorola chips. Each company had well over a hundred R&D staff[26], and they spent about US$10m each annually on R&D, typically working simultaneously on ten or more new designs for main circuit boards, secondary boards and peripherals (Interviews, Devadas 1988, Hutnik 1988a, Wipro Corporation 1988). All three companies have produced machines before any other company in the world[27], and have started exporting such machines or their designs (Darshini 1989a, Dataquest 1990e, Perry 1990).

R&D staff also work on operating systems software. Prior to 1984, most Indian computer companies wrote their own operating systems software (Cleetus 1984a) but, with the arrival of IBM-compatible PCs and the generic operating system MS-DOS, such indigenous development was no longer required. However, design innovators kept writing their own operating systems in areas of relatively low global competition, such as multi-user or multiprocessor operating systems.

The decision to push Unix as an operating system also affected this work because most of the companies obtained Unix source code which they could then modify. All of them have made minor modifications to allow Unix to run on the computers they have designed and HCL and WITL have made some fairly major changes to produce Unix-based compilers for other programming languages, Unix utilities with higher performance than the originals, and multiprocessor versions of Unix (Jaikumar & Hutnik 1988, Khanna 1988b, Dataquest 1989a)[28]. The Department of Electronics has helped in this by co-ordinating and funding Unix import substitution work (Malhotra 1987).

Finally, these companies also have a 'strong manufacturing capability' in their large computer manufacturing plants and they tend to incorporate a much higher proportion of local components into their computers than other firms, thus aiding the expansion of the local component industry (Jaikumar & Hutnik 1988)[29].

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26 Design innovators provide more local employment per computer sold than assembly companies (Joseph 1989).

27 They produced the world's first Intel i486-based computer; multiprocessing board superminicomputer; RISC (Reduced Instruction Set Chip)-based multiprocessing minicomputer; and Motorola-based multiprocessing Unix minicomputer (Devadas 1988, Dataquest 1989a, Dataquest 1989q, Tandon 1989a, Pawar 1990).

28 Specialist skills in computerised banking systems have also resulted (Khanna 1988b).

29 There are likely to have been other externalities thanks to the build-up of local technological capabilities, with spin-offs from the development of a pool of skilled workers and from hardware innovations. For example, see Weiss (1988:103-104). However, it was beyond the scope of this study to investigate these.

Throughout the decade, then, a number of firms which built up skills during the early 1980s have been able to maintain those skills during the 'dormant' period of the mid-1980s and then reassert them in the last years of the decade. Such a process has also helped these companies maintain their dominant position in the Indian market. For example, there was only one change in the top five computer sellers between 1982/83 and 1989/90 (Dataquest 1984a, Dataquest 1990w).

HCL, DCM DP and WITL were among the top five computer sellers of 1982/83 (Dataquest 1984a) while HCL and DCM DP were the two largest sellers between 1978 and 1980, responsible for more than two-thirds of all computers sold (Grieco 1984:41). Together with Zenith, another old-established innovator, they controlled more than 40% of the Indian microcomputer market and nearly 60% of the mini- and superminicomputer market in 1989/90 (Dataquest 1990w).

At the same time, however, there were a number of companies which were rather smaller in the early 1980s but which did have a design and production capability. Some of these have not fared well. Since 1984, they have found themselves unable to compete or invest effectively against imports. They have shifted to assembly-type production and to agency collaborations, and have moved design staff into simpler jobs, into marketing or have lost them to companies with substantial R&D teams. As a result, these companies have slipped well down the 'league table' of producers.

III. Collaborators

These are Indian computer companies which import much of the technology for the computers they produce. They import it from a foreign hardware firm with which they are in collaboration. Collaborations can be import agency operations, or technical collaborations or joint equity ventures which manufacture computers in India.

The nature of the local company's activity varies from being agents for complete computers imported with a government licence, to assembly of knocked-down kits, to hardware system integration in which they bring together imported circuit boards and monitors with locally-produced disk drives and operating software.

The number of such collaborations has risen sharply, from 15 in 1985 to 41 in 1988, with a further 15 being agreed by the end of 1989 (Interviews, IDC 1988a, Dataquest 1990w)[30]. The nature of foreign involvement had also changed. Between 1985 and 1990,

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[30] Further details about collaborations can be found in EIU (1986:102), Muralidharan (1988), Plus (1988) and Appendix A.

collaborations involving production in India rose from roughly half to two-thirds of all collaborations, and instead of two there were nine joint equity ventures. Although the 1984 hardware policy brought no explicit changes to foreign collaboration policy, such collaborations were made procedurally easier to undertake. However, this does not explain the increase in collaborations.

Indian companies seek out such collaborations as an alternative to investing in R&D, as a way to access the most recent technologies[31], and because some feel that foreign technology must be better than that which is produced locally (GoI 1987e). In a competitive market, those with few R&D-related resources or inclinations are tempted to take this route or, like DCM DP in the quote above, they may feel forced to do so. This feeling is strengthened by the preference Indian consumers have shown for imported rather than indigenous technology over and above considerations of cost or performance (which makes it harder for local producers to compete) (GoI 1987e).

The technology involved is a variable in this. For example, the technical complexity of mainframe design and production and the proprietary nature of mainframe processors, circuit board designs and operating systems has meant that entry into mainframe production 'is a virtual impossibility at present' (O'Connor 1985), and India has had to rely on foreign collaborations.

Foreign suppliers have been pushing such collaborations as the hardware market in India has grown. They tie up with Indian companies to ensure that their products are well marketed and supported. They push for production in India to take advantage of low production costs; to avoid import licences and duties on complete computers; and to achieve greater control over the decision making of their Indian collaborators. Import liberalisation of components and peripherals will have encouraged the growth in local production, though so too has continued import protection of complete computer systems. Foreign companies come to manufacture in India in order to avoid this import barrier.

Given the background of many collaborating companies in trading or assembly (GoI 1987e), it is not surprising that their technological capabilities were generally lower than those of design innovators. As a generalisation, one can say that many collaborating firms lie between assemblers and design innovators on a scale of technological capability.

Capabilities in agency operations were largely restricted to software services, while R&D in other types of collaboration seemed more limited than that of the design innovators. It appeared likely that there were fewer R&D workers in collaborating companies and that

[31] Though, until recently, many computer multinationals would not licence their state-of-the-art technologies (O'Connor 1985).

they were oriented more towards local sourcing of components in order to fit in with the government's phased manufacturing programme[32], and towards the development of applications software and other adaptations to local conditions rather than towards design innovations[33]. The work of one such company was described:

> "We are not involved in any basic developmental work in the strict sense of the word ... Rather we would like to look at a product and see what enhancements we can offer, by way of system software, operating systems, ruggedization, etc" (Jaikumar & Hutnik 1988)

These collaborating companies therefore rely on the R&D carried out in developed countries and embodied in imported technology rather than on their own efforts (see also Harrison 1978, ISG 1985, O'Connor 1985, Swaminathan 1988a). Because of the opportunity costs of this form of production within a technologically capable industry and the competition with more capable local firms, collaboration has therefore tended to reduce the extent of local design and research and development work (GoI 1987d)[34].

Present and future balance within the industry

There is no sharp division between the categories described here, but more of a continuum of capabilities from assemblers through collaborators to design innovators. The different activities can also be found within the same firm. WITL, for example, designs and produces its own micro- and minicomputers, builds workstations in India through a technical collaboration with Sun Microsystems, and is the agent for imported Convex minisupercomputers.

There is also movement between the categories. Some of the firms which developed as design innovators in the early 1980s began life assembling imported goods, sometimes through collaboration with a foreign supplier. Conversely, some firms which were designing and building their own computers in the early 1980s now rely entirely on imports and collaborations. However, none of the assemblers or foreign collaborators that

32 Under this system of regulations, computer manufacturers can import all inputs when they start to make a new model of computer but the proportion of local inputs must be gradually increased over 3-4 years. The system has not worked very well because it is not linked to a programme to improve costs and quality of local inputs, because companies default, and because new computers are introduced every two years or so, leaving little time for indigenisation before the new model starts afresh with 100% imports. See GoI (1987d), GoI (1987e), IDC (1987), Jaikumar & Hutnik (1988), Muralidharan (1988) and Times of India (1988).

33 Data from interviews and GoI (1987d). Hewitt (1988) describes similar evidence from Brazil. There, around 13% of staff in local computer firms were working on R&D compared to only 3.5% in foreign subsidiaries.

34 *See also Ribiero (1988a) and Evans & Tigre (*1989). Khan (1990) cites the specific example of the loss of the Indian firm PSI's R&D capabilities when it was taken over by the French computer company Bull.

grew up in the wake of the 1984 liberalisations had shown itself capable of any substantial design or innovation up to 1990.

The historical trends within the industry can be seen more clearly in terms of computer types. Assembly has always been confined to microcomputers and seems likely to stay that way, but it has been slowly widening from basic PCs to more powerful 80286-based machines. Design innovators built up their capabilities on microprocessor-based systems. As microprocessors have become increasingly powerful, they have been able to form the basis for minicomputers and even 'superminicomputers' as well as microcomputers. The capabilities of these companies have therefore been migrating up the computer system spectrum in line with technical changes.

Throughout the 1960s, 1970s and early 1980s, collaborations remained largely confined to the realms of mainframe computers. However, since that time, they have migrated down the computer system spectrum. Collaborations in microcomputer production have not been encouraged by government and only one or two of these exist as part of a larger collaboration agreement, but by 1990 there were several minicomputer and workstation collaborations[35].

In 1990, the computer market in India could therefore be summarised as indicated in table 6.4.

Table 6.4

Summary of Indian computer production in 1990

Computer type	Position in 1990
Microcomputers	Competition between kit assemblers and design innovators
Minicomputers and workstations	Competition between foreign collaborations and design innovators
Mainframes	Domination by foreign collaborations

Summary

There are two ways of viewing the Indian computer industry of 1990. From one viewpoint, the vast majority of companies were hand-assembling imported kits, while

35 These include many of the major world producers such as DEC, Unisys, Hewlett-Packard, Bull and Olivetti. IDC (1988a) also notes the collaborative presence of most major IT players.

companies which rely on foreign technology collaborations were experiencing rapid growth, leaving only a handful of genuine indigenous producers.

The computer industry is highly R&D intensive, with US companies spending 8-10% of revenue on R&D (O'Connor 1985, IDC 1988a). By comparison, Indian computer companies spend, on average, 1% of revenue on R&D and many small companies spend nothing. Import liberalisation has played an important role in this.

> "Overall the import of technology into India has very often been a substitute rather than an input to Indian R and D" (Swaminathan 1988a)

Hardware import liberalisation has led to 'hundreds of assembly operations with little to show in the way of indigenisation of know-how or components.' (Bagchi 1990), and has assisted the growth of foreign collaborations.

The flood of imports and foreign collaborations following the 1984 policy change drowned out local capabilities which had been nurtured during times of greater protection against imports. Once the floodwaters of import liberalisation began to recede after 1987 some of those local capabilities re-emerged in the strongest of the pre-liberalisation companies. But the capabilities of other firms seem likely to have been lost for good to those firms.

On the other hand, one may take a more positive view. Some Indian companies, including the two market dominators have a wealth of capabilities. They design their own hardware, importing only those components, such as processors, which can only be produced by the largest multinational corporations. They have produced leading-edge designs and now export their computers to developed country markets. They have substantial manufacturing capabilities but it is in design - of both hardware and operating systems software - that they excel. Thanks to this and to export barriers, they have been more successful at exporting designs than computers.

Computer and kit import liberalisation in the mid-'80s was potentially very damaging, but these companies were able to divert skills and resources into more protected areas, aided by government policies on imports and foreign collaborations. They have benefited from liberalisation of component imports but also from government demand policies, particularly the Rangarajan committee report.

A critical problem for computer industries in developing countries in the late 1980s has been the question of how to move beyond just producing IBM-compatible computers (Evans & Tigre 1989). The Indian hardware industry has been able to do this, thanks to the Rangarajan decision that can be regarded as either very fortunate or very far-sighted given that Unix was not very widely used in 1984, but has subsequently come to dominate the world workstation and minicomputer market, with a global market likely to reach US$20bn by 1991 (Schware 1989:11, Schofield 1990b), as well as strong growth within India itself (Skaria 1989).

Most of the other Indian companies have some technological capabilities, ranging from simple technology choice and assembly to systems integration and adaptation. Had open import of complete computer systems been permitted, these are unlikely to have developed, or to have developed to such an extent[36], and they provide a base which may potentially grow into higher capabilities.

Judging by past experience, firms are equally able to move up or down the scale of capability depending on the circumstances. It is therefore not possible to predict whether the most capable local producers will be able to expand their hold on the market; whether assemblers and collaborators will become increasingly technologically capable; or whether local design innovators will be squeezed out by the foreign technology imported by assemblers and foreign collaborations. What does seem clear is that government policy, particularly on imports, will be an important determinant of future changes in the industrial profile.

3. Conclusions

From the findings about both hardware and software package production, a number of conclusions can now be drawn.

Technology

As has been stressed in previous chapters, policy is not the only factor affecting industrial development. The nature of the technology and of technical change has clearly been an important element in the development of India's hardware industry. Falling real prices of components and computers, the arrival of the microprocessor and the simplicity of the PC standard have all assisted the growth of production in India and the entry of small firms[37].

The speed and cost of technical innovation have also affected production. Where technology has been relatively stable, Indian firms have found it easy to enter and even be price competitive internationally. Where technology has been fast changing and innovation

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36 Schmitz (1984:8) also associated imports with a slowing of capability development.

37 See also Grieco (1982) and Jaikumar & Krishna (1987).

costly, fear of obsolescence has discouraged investment (Dataquest 1983b, Jaikumar & Hutnik 1988). In some cases, only the most capable and innovative firms have been able to compete and even they have not achieved any fundamental innovations. In the case of mainframes and of most processors, Indian firms cannot hope to compete at all, because of the huge R&D costs involved.

Local production decisions have also been partly determined by the proprietary or generic nature of technologies. Generic operating systems have stifled major software innovations but have enhanced minor innovation, opened up wider markets for hardware design innovators, and helped small firms become hardware producers. Proprietary operating systems and processors, where well protected legally, have 'locked out' all except those that are willing to enter into collaboration with the supplier.

All this means that the Indian IT industry, like that of all nations, cannot hope to achieve 'technological independence' (Cline 1987:145). It must import some computing and component technologies even if it can produce others locally. Technology import policy and foreign collaboration policy should therefore be differentiated according to the type of technology. This is particularly clear with a technology like software, which is so unlike others.

Non-import policies

Though import policy is a key part of government efforts to build an indigenous industry, complementary policies also matter (Lall 1987:12, Gaio 1989:218-23,252). Controls on foreign firms and imports need to be supported by promotional measures to encourage local adaptation of imports and local research and development (Fransman 1986:67, Lall 1987:238, Swaminathan 1988a). As will be discussed in chapter 8, government has established policies on local R&D.

The coupling of government demand policies with some level of computer import protection has been central to the growth of production within India, just as its rather weaker efforts on software package demand and piracy have probably restricted growth of that local industry.

Policy on software package and hardware export has done relatively little to address export barriers. It is a legacy of India's negative experiences with computing multinationals in the 1960s and 1970s that policy has been more concerned with import protection than with other aspects such as export promotion. The need for government action to help redress the balance between domestic- and export-oriented production was being recognised at the end of the 1980s.

As well as the complementarity of other policies, the phasing of such policies may also be important. For example, many writers[38] feel that a period of strong domestic competition needs to come before any import liberalisation. This was the case in Indian hardware policy with the major relaxations in industrial licensing preceding import liberalisation by several years. The generally beneficial outcomes of this have already been noted in chapter 4, with licensing liberalisation in the late 1970s encouraging competition and the build-up of computer-related technological capabilities which have been so important to India's hardware industry during the 1980s[39].

Impact of import protection

One of the catch-phrases used by interviewees who were in favour of liberal imports was 'let us not re-invent the wheel'[40]. They argued that it was wasteful to try to develop technologies locally when such technologies could more quickly and cheaply be imported. This outlook takes only a static view of the situation and it also neglects India's experience in the 1960s, when the lack of local production capabilities left the country dependent on imports of outdated equipment from multinationals.

The protection from imports offered between 1972 and 1983/84 allowed Indian firms to re-invent a few 'wheels' by reverse engineering foreign products as a result of which there was a build-up of indigenous production and indigenous technological capabilities, particularly design capability.

> "The consequences of a policy of protecting not just production, but also 'know-why' is that India has developed a capability to both manufacture and design a wide range of industrial products." (Weiss 1988:243)

It is this, more than anything else, which has provided the base for the impressive growth and design innovation seen in a few large firms in the late 1980s. Protection, and the consequent increase in technological capabilities, has also helped to reduce technological dependence on the multinationals (Grieco 1982, Lall 1987:20) and to compensate for Indian firms' difficulties in achieving scale economies through exports.

> "For most developing countries, a certain amount of protection would appear to be necessary to counterbalance the

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38 Including Ghosh (1987), Lall (1987:240), Patel (1987:168-69), Wiemann (1987), Lucas (1988), Foley (1989:9-10) and Kydd & Spooner (1990).

39 Though, as seen in relation to both hardware and software domestic markets, too high a level of competition may stifle capabilities and innovation.

40 See also Computers Today (1986c) and Hebalkar (1987) for software-related examples.

enormous technological and cost advantages enjoyed by the computer industries of the advanced industrialized countries" (O'Connor 1985)

There seems little doubt that government intervention to protect industries helps indigenous technological capabilities to grow, and that technological capabilities in a new industry will not grow without some protection. This point has been made about the Indian hardware industry (Dataquest 1987b, Singh & Ghosh 1988); about other national hardware industries (Cline 1987:16,29,137-38, Schmitz & Hewitt 1989); about other Indian industries (Lall 1984a quoted in Fransman 1986:89, Lall 1987:240); and about industry in general (Weiss 1988:243-44).

In the 1980s, it is only where protected from imports (and the foreign collaborations that bring them) that Indian companies have been able to develop software package and hardware development design skills. If, instead, India had continued to rely on foreign imports, it is hard to see how local production capabilities could have been built up.

As a concrete example, in 1990, a brief survey of the Malaysian computer industry was conducted. The Malaysian government has maintained an open import policy. Although other factors, particularly market size, have an impact, the lack of protection seems at least partly responsible for the Malaysian computer industry's heavy reliance on the import of complete computer systems. A few companies were assembling imported kits but none had any design capability in either hardware or systems software.

An alternative to protection is the use of subsidies to local producers which, it is argued, create less economic distortions than protection (Cline 1987:14). But where, as in India's case, government financial resources are too limited, protection remains a second-best option.

Impact of Import liberalisation

There are signs (Grieco 1982, Shekhar 1988) that Indian producers were becoming more efficient and were building more up-to-date, competitively priced products during the early part of the 1980s. Had policies remained the same, it is possible that they would have carried on improving behind the barriers of import protection.

However, the computers produced at that time were more costly and less up-to-date technically than world standards. The combined arrival of the IBM PC and of Rajiv Gandhi as Prime Minister shifted the focus from the benefits of protection for local production to the costs of protection for local consumption. The dominant concern came to be that import protection was allowing the Indian industry to be insulated from global technological progress and efficiency levels (EIU 1986:101, Kaplinsky 1987)[41]. Imports of both components and computers were duly liberalised.

Introducing import liberalisation into this import-substituting industry allowed the massive increase in demand to be met largely by direct imports, by import and assembly of computer kits, by foreign collaborations, and by a large outflow of foreign exchange. All of these had a role to play in the suppression of local research and development and of local technological capabilities[42].

What local production and capabilities there were remained partly through continuing protection. Only those firms with technological capabilities that pre-dated the major import liberalisations still had those capabilities in the late 1980s, though protection also encouraged some level of capabilities in assembly and collaborating firms that might not otherwise have arisen.

As already discussed, import liberalisation did help to bring some benefits to consumers; and producers, too, felt some positive impact. Some software package production was stimulated and import liberalisation may have had a positive effect on those firms with pre-existing capabilities which survived the mid-1980s. The director of one such company stated that there had been benefits in import liberalisation in that his company and others like it 'are now more alert to competition, to advances in technology, etc' (Ribiero 1988b).

Cline (1987:142) and Weiss (1988:243-44) review evidence of successful policy strategies from both India and China and conclude that while initial protection is needed to build capabilities, 'there are limits to this process, and that beyond some point an infusion of foreign technology and imports will be required to strengthen and complement domestic resources.' (Weiss 1988:299).

This therefore suggests the possible utility of some kind of phasing of import policy, with import liberalisation following import protection[43]. However, two points are worth making. Firstly, it is widely seen that import liberalisation in the mid-1980s went too

41 Lall (1984b), Fransman (1986:89), Verghese (1986), Cline (1987:16,29) and Schmitz & Hewitt (1989) also review the balance between capabilities and insulation associated with protectionism. Other writers who are critical of India's protectionist policies during the 1970s include Ahluwalia (1985) quoted in Singh & Ghosh (1988), Alam (1985), Reddy (1987:200-201) and Wiemann (1987), though their criticisms often focus more on industrial controls than import protection.

42 Datt (1987b:192) surmises the same from a study of the whole of Indian industry.

43 Also recommended by Evans & Alizadeh (1984), Kaplinsky (1984b), Schmitz (1984), Fransman (1986:83), Cline (1987:16-17, 146-48) and Bagchi (1990). Those who believe that protection must have a designated end-point disagree over the protection period, though neo-liberal writers tend to argue for a much shorter timespan than others.

far, with subsequent policy reversals showing that 'the Government is tacitly accepting its mistake in opening the import-window rather too wide.' (Datt 1987b:192).

Secondly, any benefits to design innovators were more from liberalisation of component imports, which they could use to upgrade their systems, rather than kit and complete systems imports, which merely provided direct competition. Any impetus from such competition and from technology upgradation gains must be set against the skills loss in those firms which gave up design innovation in the mid-'80s and against the impact of component liberalisation on the component industry. Although this research did not include a detailed qualitative survey of the Indian component industry, it seems likely that component-related capabilities were suppressed by imports.

Overall, then, one can take no simple, polarised view of either foreign collaboration or import liberalisation. Many Indian companies have sought and welcomed collaborations. Collaborations may also form the basis for some build-up of technological capabilities but they have more often been associated with a loss or stifling of such capabilities.

Similarly, import liberalisation has produced a form of growth but also a type of dependence, with improvements in consumption-related factors being matched by growing dependence on foreign sources of technology and innovation, and a lack of local capabilities[44]. Fortunately, the Indian government never permitted complete import liberalisation, always retained some protection, and reversed liberalisations once their negative implications became clearer.

Importance of government policy

Despite the other factors described above, policy has been an important determinant of the changes in software and hardware production within India[45]. Even when liberalising, the government has retained strong control over imports and other activities. It has also retained the ability to react and to change policy when necessary. Chapter 8 highlights the importance of these reactions in relation to software industry development. This chapter has shown that throughout the history of the hardware industry, reactions and changes in government policy have been the dominant factors in delineating the changing phases and nature of the industry.

During the 1970s, government hardware policy was successfully modified to address the two principal problems relating to computers - firstly, the complete dependence on

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[44] See also Shekhar (1988).

[45] IDC (1987) also highlights the important role of policy.

multinational firms and, later, the dependence on a single, poorly performing public sector company. The main mechanism used was altering controls over industrial entry, capacity and foreign collaboration (Grieco 1982).

During the 1980s, government policy was successfully modified to address the problems it then identified - firstly, the low levels of use of the costly, out-of-date equipment produced locally and, later, a re-emerging danger of import dependence and loss of technological capability. As described in this chapter, the main mechanisms used were demand stimulation and alteration of import controls.

Of course, no government is perfect. It is arguable that the Indian government 'overdid' the industrial protection of the mid-1970s and the import liberalisation of the mid-1980s. Nevertheless, it successfully responded to the problems created and modified policy in order to help solve them[46]. Partly thanks to this, by 1990 there were more than 200,000 computers installed in India compared to only 1000 in 1980. Yet at the same time, the Indian hardware industry had grown strongly, with hardware company revenues exceeding US$650m in 1989/90, including those of some companies which were designing and exporting computers at the forefront of hardware technology.

Thus, over and above, any particular findings about protection or liberalisation, it is government's ability to change and apply various appropriate policy measures that can be held at least partly accountable for the positive developments in Indian computer use and production.

Timing and type of policy

> "Government intervention is apt to be essential, but what form that intervention takes is critically important."
> (O'Connor 1985)

The results from chapters 5 and 6 suggest that import liberalisation can help to bring benefits to some consumers and some consumption-related developments, but can be harmful to some producers and production-related developments. Import protection has arguably more virtues, but continuous high levels of protection are likely to lead to inefficiency and to a greater concern with local sourcing and adaptation than with innovation and use of up-to-date technology[47].

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[46] Cline (1987:142-43), too, points out the way in which government has been reactive and changed hardware policy over time.

[47] See Dahlman & Sercovich (1984), Teitel (1984:13) in Fransman (1986:85), Cline (1987:17), Weiss (1988:228-36,298) and Colclough (1989:6).

Therefore, there can be no sweeping prescriptions about the form of government policy. Both liberalisation and protectionism may have a place, but timing is critical.

The Indian government had to start with allowing imports; then closed them off to help build local capabilities; opened them again to allow technology to be updated; and then closed them off again to preserve local capabilities. It seems certain that neither continuous import protection nor continuous import liberalism would have been appropriate strategies to produce the growth of, but also balance between, production and use.

This is not to argue that the open-close cycle is necessarily the recipe for success in other industries or countries (though it might be). Instead, policy choice at any given time should be determined by the present state of industrial capabilities, relations with foreign companies, changes in technology, changes in the global macroeconomy, and the balance of government concern between local consumption and production. Governments therefore succeed by continually monitoring industrial and external circumstances; by being selective in their policy choices; and by a mixture of some planning and some reaction to the circumstances they find.

CHAPTER 7

FOREIGN COLLABORATIONS

Introduction

The presence and activities of foreign firms have been a recurring theme throughout the discussions so far on policy and industrial development. This chapter deals explicitly with the nature, causes and consequences of links between the Indian software industry and foreign companies.

The findings of the chapter suggest that there are many different forms of such links, from informal contacts by company managers to full foreign ownership, but that there has been an increasing number of all types during the 1980s and particularly in the latter half of the decade. The familiar argument will be advanced that foreign collaboration policy liberalisation (seen in attitude and procedural changes as much as in written policy) has been only one among a number of factors which explain this increase. Other policy measures and other factors, including a desire to access the Indian market and the importance of close consumer-producer relations, have also had an impact.

Collaborations have been encouraged in order to try to overcome some of the skill, capital, technology and marketing constraints that have beset the Indian software industry. Many collaborations have helped to supply these inputs and they have formed a vital part of India's software export growth. However, there is another side to collaborations. They have been of relatively little benefit to domestic-oriented needs; have been associated with export vulnerability and technological dependence; and their growth increasingly constrains the policy options available to the Indian government. Chapter 8 will therefore look at alternative ways of improving access to skills, capital and marketing without incurring so many costs.

1. Extent and types of collaboration

1.1. Extent of collaboration and investment

There were an increasing number of software-related collaborations in India during the 1980s[1]. Over 80% of these collaborations were with US companies, the rest being one or two each from a number of European countries[2]. Table 7.1 shows the start-up dates of the major, formal collaborations in hardware, software distribution and software export[3].

Table 7.1

Start-up date of Indian hardware and software collaborations

Year	Hardware	Software Distribution	Software Production	Cumulative total for all software
Pre-1980	5	-	4	4
1980	1	-	1	5
1981	1	-	1	6
1982	-	-	-	6
1983	1	-	-	6
1984	1	-	1	7
1985	6	-	1	8
1986	12	1	2	11
1987	14	10	4	25
1988	2	6	4	35
1989	13	7	4	46
1990	-	5	4	55
Unknown	1	5	2	62

Source: Interviews, Dataquest (1984a), Dataquest (1987e), Dataquest (1989l) and Dataquest (1990w).

The figures indicate that there has been a dramatic increase in software (and hardware) collaborations since the mid-1980s, which suggests some possible link to policy changes. Approximate figures on investment, already noted in chapter 4, suggest that foreign multinationals had invested about US$15m in wholly export-oriented software firms up to

1 Mirroring a global trend towards collaboration in the software industry (Coopers & Lybrand/IDC 1986, Financial Times 1987, Schware 1989:8-9,72, Sridharan 1989).

2 Sayer & Morgan (1987) criticise those who mistake national characteristics of US multinationals for general characteristics of all foreign capital. Page (1987), for example, reports that US companies have operated on shorter time horizons and with greater concern about cheap labour and offshore production for home market consumption than companies from other developed countries. Given the available resources and the domination in Indian software collaborations of US companies, it was not possible for this current survey to focus on national differences in collaborations, but it should be noted that the findings presented here may be representative of US more than global capital.

3 Figures for 1990 were not complete at the time of writing, while figures for all years exclude some minor collaborations and all informal collaborations. Many more collaborations than this have been approved by government but never become active (see, for example, EI&P 1986a). A list of hardware- and software-related collaborations is provided in Appendix A.

mid-1990, with almost all of this being in the second half of the 1980s, again suggesting a possible link to policy.

1.2. Types of collaboration

The various collaborations relating to software in India can be differentiated in three main ways - by type of work, relationship and foreign company.

I. Type of work

Software distribution. As already described in chapter 5, these collaborations involve an Indian company acting as the local agent for a foreign supplier's software packages; and undertaking sales, marketing, support and training.

Software production. In most cases, the focus of such arrangements is wholly or primarily on software services exports from India. The foreign company uses the Indian firm as a source of software labour to service its own needs or those of its customers. For the Indian company, this provides a steady supply of export work, either directly from the foreign company or through its marketing network. The importance of these relationships for software exports was noted in chapter 3. In the case of some large exporters, the creation of the Indian software company has been initiated by a foreign multinational, such as Citibank, Texas Instruments and Unisys.

Systems integration. These collaborations are focused mainly on the Indian domestic market and integrate foreign hardware with local software services to create a complete computer system to serve local client requirements.

Hardware distribution/production. These were described in chapter 6 and are not the central concern here.

II. Type of relationship

Wholly-owned subsidiary. These are comparatively rare in number[4], being only permitted for export-only operations. By late 1990, only five were operational though this did include two of the top five software exporters of 1989-90.

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[4] A point also made by O'Connor (1985).

Joint equity. In these cases, the foreign company owns 40% of the Indian company's equity, which is the maximum permissible for most companies wishing to sell goods to the domestic, as well as export, market. Many of these companies are set up by foreign hardware companies to sell computers to Indian customers and they have only a secondary interest in software.

12% of India's 1989/90 software exports came from companies which had foreign capital invested specifically for software production; a further 24% came from companies with foreign equity initially invested primarily for hardware production (Dataquest 1990w).

Overseas equity holdings. By early 1990, four medium-sized Indian software producers had taken up 40-50% equity shares in software companies based overseas[5]. Because overseas subsidiaries of Indian companies are viewed with some suspicion by the Indian government, regulations make the export of capital difficult and time-consuming (Computers Today 1986c, Computers Today 1987b, Nabhi 1988:159). Indian exporters have therefore paid for their share by taking a loan from the foreign collaborator and then repaying it through profits from export work.

Such investments are risky but they offer the Indian company a base for marketing products and for obtaining contracts and market information. They can also create the basis for a more controllable and stable long-term relationship than that created by some foreign investments in India.

Agency/distribution agreements. These have already been described.

Technology transfer and technical collaboration agreements. Though quite normal in hardware, these are rarely seen in software, perhaps because of the difficulty of control when dealing with an intangible product[6].

Contractual arrangements. These may not be completely formalised, but represent a close relationship in which the foreign company is the main source for the Indian firm's software export contracts. It is this type of arrangement that frequently exists between foreign hardware firms and their Indian distributors, with a reciprocity such that the Indian firm sells foreign hardware and the foreign firm buys Indian software services, with both firms benefiting from both sides of the arrangement.

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5 See, for example, Dataquest (1988e) and Dataquest (1990g).

6 The exception has been a handful of systems software transfers, as described in chapter 6.

Informal arrangements also exist between Indian software exporters and contracting agencies overseas. Usually without offering any guarantees, the agency will source most of its labour from the Indian company, while the Indian company will obtain most of its contracts in that particular foreign market through the agency.

III. Type of foreign company

Hardware multinationals. Collaborations involving foreign hardware manufacturers are an important source of both export contracts and, to a lesser extent, domestic market production. By 1990, the majority of the largest US hardware manufacturers (including IBM) had some link-up with an Indian software-producing company.

Software multinationals. Up to mid-1990, no foreign software product company had made a direct investment in India but many of the world's largest software package vendors have entered into distribution agreements with Indian companies (Pawar 1989, Schware 1989:24).

Other multinationals. A few other types of foreign company have entered into collaborations, including Citibank (banking), British Telecom (telecommunications) and Bakst International (software services).

Contracting agencies. Apart from direct contracting for a foreign collaborator or company, the other common form of software export from India involves foreign contracting agencies[7]. Many of these are run by non-resident Indians, and they work by accepting contracts from the end client and then subcontracting it to the Indian company, after taking off some commission (typically 40%). The role of the agency varies from those which pay for air fares, insurance and holidays, to others which treat the contract workers very badly (Hockenhull 1989, Widge 1990).

Most contracts involve the provision of onsite, time and materials-billed programming services. Most Indian companies use these agencies to some extent (Widge 1990), though larger companies tend to rely more on their collaborators or their own marketing operations overseas. Some small Indian companies just act as 'head-hunters', finding suitable workers in India in response to a 'shopping list' from the contracting agency, and collecting a flat rate fee in return.

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[7] Known in the US as a 'body shop'. Hence the use of the term 'body shopping' to describe the provision of onsite programming services.

Type of Indian company. As might be expected, most formal collaborations involve the larger, longer-established Indian companies. Unlike small, new companies, they have the ability to seek out foreign partners, and the reputation and marketing contacts to convince foreign companies looking for distribution agencies or software labour sources. The only exception has been where the small, new company is a spin-off created by staff leaving a larger, older company, in which case reputation and credibility reside with the staff rather than the company name.

1.3. Examples of specific collaborations

The above analysis draws out various possible categorisations, but some brief 'thumbnail sketches' provide a better picture of what collaborations actually involve.

Tata Unisys Ltd (TUL)

Tata Unisys Ltd was the largest software exporter involved in a formal foreign collaboration during the 1980s. It is of particular interest because 'The DoE is apparently seeking to replicate the TUL experience in collaboration with other giants of the world computer industry' (Muralidharan 1988).

Following the relationship between the US computer company Burroughs and the Indian software company Tata Consultancy Services in the 1970s, Burroughs and TCS decided to set up a separate company to manufacture computers for the Indian market. However, foreign hardware companies were out of favour with the Indian government at that time, so that when Tata Burroughs Ltd was first floated late in 1976, with 50% Burroughs equity, it was intended to manufacture computer peripherals, largely for export (GoI 1978:112, EI&P 1985e). Only later was the foreign equity diluted to 40% to allow sales of computers to the domestic market (Computers Today 1985b).

However, sales of both peripherals and computers had very limited success compared to the ability of TBL to earn money from undertaking software export work for Burroughs. Throughout the company's history, there has therefore been a tension between the American company's primary desire to sell hardware, and the greater ease with which the Indian partner could earn money from software exports (Computers Today 1988b, IDC 1988a).

Nevertheless, Unisys (as Burroughs became in 1986 after its merger with Sperry) has been able to export hardware and components to India and, because of its primary interest in hardware sales, it has ensured that TUL's software export abilities are used as a lever for hardware sales overseas.

Typically, Unisys computer sales reps go to a potential customer site in the US where, say, an IBM machine is currently installed. Thanks to the TUL's low costs, Unisys can promise to convert all the existing IBM-based software to run on Unisys hardware for free (i.e. included in the sale price of the hardware) and that any new applications the customer wants can be written for two-thirds the market rate and will be ready by the time the Unisys computer is installed. The ability to contract out such work also allows Unisys to retain corporate flexibility by keeping the number of its core staff low.

What TUL has gained from the relationship is a certain amount of imported technology and training and a large, easily-accessible market for its exports. 'In the case of TUL, a collaboration with the US based Unisys Corp enabled it to corner the software market on Unisys systems in several parts of the world.' (Widge 1990) and, in the late 1970s, 100% of TUL's software work came from Unisys. However, this is a two-edged sword - 'TUL is thus essentially a captive vendor of software, whose fortunes are closely linked to those of its sole customer' (Muralidharan 1988). Thus, according to an ex-TUL manager, 'TUL's US marketing offices are basically there to take orders from Unisys. Life is easy but very dependent.'

TUL has had to accept large amounts of low skill, onsite conversion work from Unisys; has suffered very high staff turnover rates as a result; and has also suffered, as in 1985 and 1989, when Unisys sales were poor. As a result, TUL management has deliberately attempted to diversify operations away from Unisys, but this has met with only limited success - by 1988/89, 85% of TUL's work was still for Unisys or its customers.

Citicorp Overseas Software Ltd (COSL)

COSL was India's third largest software exporter in the late 1980s and was both the largest and the first wholly foreign-owned, wholly export-oriented software company in India.

Ideas about setting up an offshore software company in India were mooted within Citibank, the US-based global banking group, in 1979 and were encouraged by Indian-born staff working within the organisation. However, at that time senior staff felt that the bureaucratic and political climate, in India and globally (such as poor Indo-US relations), were not conducive to such a move.

This feeling was altered after the arrival of a new Indian government and more liberal hardware and software policies in late 1984. Government officials were more encouraging about foreign investments; they confirmed the applicability of various policy incentives to software exports (a point subsequently made explicit in the 1986 software policy); and they promised help with a speedy approval of the company's creation.

COSL was set up in the Santa Cruz Electronics Export Processing Zone in Bombay in 1985 with a dozen or so experienced administrators and software staff drawn from other companies. After that time and up to 1990, growth was rapid. About US$1m was invested, mainly in microcomputers and software tools imported from the US (GoI 1989c), and gross exports grew from just under US$1m in 1986/87 to more than US$5m in 1989/90 with more than 250 staff employed (Dataquest 1990w). Thanks to a comprehensive staff training programme, much of it conducted in the US, many of the staff had substantial software development and project management skills.

COSL initially marketed its services internally within Citibank using in-house contacts, journals and exhibitions, and it worked only for Citibank. It then diversified to work for other banking clients, though Citibank remained the major customer. Thanks to the development of Seepz' and India's telecommunications infrastructure, and the alteration of legislation on international communications, COSL was able to contact Citibank and other offices all over the world by electronic means.

Like most Indian software exporters, COSL began by undertaking onsite programming jobs. However, it rapidly established its reputation within Citibank and, by 1989/90, more than 80% of its contracts were for offshore, turnkey work (Dataquest 1990w). Despite the fact that this work was carried out in India, COSL was something of an enclave, there being few links between it and the rest of the Indian economy.

1.4. Summary and conclusions

There has been a substantial increase in the number and diversity of software-related collaborations and investments in India in the latter half of the 1980s. Both this fact and the role of government described in TUL's and COSL's creation suggest that government policy has had a role to play in collaboration decisions. How much of a role will be discussed in the next section.

There are several different forms of collaboration arrangement, but four predominate, which are listed below in increasing 'closeness' of collaboration.

- Informal subcontracting arrangements with foreign contracting agencies to sell software services exports.
- Distribution agreements to sell foreign software packages in India.
- Semi-formal contracting and joint equity ventures with foreign hardware companies to sell software services exports and some domestic software services as a complement to hardware sales.
- Wholly foreign-owned and/or wholly foreign-controlled multinational subsidiaries to sell software services exports.

These may be placed in relative decreasing order of importance to Indian software exports as follows - hardware company links, foreign contracting agencies, foreign-controlled companies. The last was becoming increasingly important in the late 1980s, while only the contracting agency option was open to most small or new Indian companies. It is notable that while most studies of the relationship between developing countries and foreign companies focus on investment and/or technology transfer, here there are a whole set of less formalised yet important collaborations, while investment has been relatively rare, at least in numerical terms.

The brief case studies already presented suggest that there will be benefits and costs associated with these collaborations and that different collaborations will be associated with different costs and benefits. These various impacts are discussed below.

2. Factors underlying collaborations

In chapters 3 and 4, various reasons were given which help to explain the internationalisation of software production - an international market for software, labour costs, adequate productivity and quality, and the global skills shortage. But these do not necessarily imply a need for foreign collaboration. Thanks to the intangibility of software and, in part, to the mobility of software labour, foreign firms can reap the benefits of internationalised production merely by recourse to basic trade in software services export.

What, then, are the additional reasons which encourage foreign and Indian companies to seek collaborations? Why do they choose one form of collaboration rather than another? And what is the role of policy in these decisions? The answers to these questions will be sought in this section.

Access to local market

Gaining access to the local market has been an important, though sometimes ignored, reason behind foreign collaboration (MacEwan 1985, Mody 1985, Page 1987, Sayer & Morgan 1987). With India's IT markets growing rapidly and likely to be worth about US$1bn by 1990/91, 'there were numerous manufacturers in the US who had been eyeing the expanding Indian market for some time.' (Sharma 1989)[8].

Foreign software package producers have preferred distribution collaborations in India to direct sales because the former allow a transfer of knowledge to the local collaborator so that it can provide local training, support and marketing for the packages and so encourage greater sales than imports alone. These producers have not needed to invest directly because of the nature of the technology:

> "This transfer of technology to foreign markets does not generally require a transfer of actual production facilities ...; in effect, reproduction and transport costs for packages are very low, so that it is economical to duplicate the package itself at a central site." (Sauvant 1986:86)

Foreign hardware producers have also pushed into distribution collaborations rather than direct sales in order to reap the benefits of local hardware training, support and marketing. Although foreign hardware producers often try to sell just software packages with their computers, many of their collaborations involve some software development in India. This is done so that local customers are provided with a complete information technology system, including software matched to their needs in a way that only local knowledge and close buyer-developer interaction can provide.

As seen in chapter 6, these hardware companies may invest directly in hardware production, but they have not tended to invest much in local domestic-oriented software production, some of which may be subcontracted.

Skills, standards and trust - factors affecting software export collaborations

Foreign firms can access the local market via trade, but have preferred collaborations. Similarly, they can access local workers and their skills by trade for software exports, but many have preferred collaboration which can offer direct, assured access to labour.

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8 Tenorio & Field (1986) also note this interest.

Hardware companies want this so that they can be sure when offering it to prospective customers outside India.

Collaborations also offer greater control over the way in which software is developed. Foreign collaborators are able to transfer technology-related skills as well as standards of working - of communication, scheduling and delivery, documentation, and so on - by training their Indian counterparts. Collaboration also means that the Indian company understands the foreign company's corporate strategy and culture well, which brings a greater assurance that the software developed will match users' needs for 'in-house' contracts.

In general, the closer the collaboration, the stronger this transfer of skills, standards and procedures has been. The multinational-controlled subsidiaries use the same manuals and methods as their parent companies, so that the latter are assured of product quality and timeliness. This assurance and trust and credibility explains why these subsidiaries have been able to take on far more offshore, turnkey work than other Indian companies. As noted already, such work offers much greater savings to the foreign buyer than onsite, programming-only development.

Conversely, without such a relationship, internationalisation can be held back by the perception of risk in internationalising production, by uncertainty over available skills and standards, and by fears of a loss of control over the process.

Indian companies and collaboration

It would not be correct to see the drive for collaboration as deriving solely from foreign firms. Indian companies, too, are keen for collaborations which, as pointed out in chapter 3, have been a very important part of software export efforts.

> "An analysis of existing software export companies shows that an entry into the market is possible only through a tie-up with a hardware manufacturer, through a sub-contractor relationship with a large software house overseas, or through consultants overseas who act as representatives for the Indian exporter. Selling directly to the customer is almost impossible in the early stages." (Saldanha 1983)[9]

Collaborations offer a way to circumvent the marketing and credibility barriers of open market competition by virtually (though not completely) guaranteeing export work.

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[9] Cooper (1983), EI&P (1985b), Mukhi & Chellam (1988) and Lakha (1990) also describe the importance of such collaborations to Indian software exports.

Indian firms are particularly motivated to seek the kind of long-term access to contracts that close collaborations provide, which removes the need to continually compete on establishing credibility and to have an expensive overseas marketing operation. Such collaborations provide access to technology (and associated skills) as well as business.

The most important time for any collaboration is in the early stages of the Indian company's life (which may last some years). Only the very largest and longest-established company - TCS - has been able to dispense somewhat (and only somewhat) with collaborations.

Those Indian companies entering into domestic distribution agreements for foreign software products have done so in order to use that product as a state-of-the-art technological lever to obtain domestic customisation work, and in the hope of winning export orders from the foreign supplier.

Although in either case they may want collaborations and may even initiate discussions, Indian firms in most of the collaborations described are not in a particularly strong bargaining position because it is the multinational which holds most of the desired resources - market access, finance, skills, particular technologies - and the multinational which can fairly easily get what it seeks - labour and/or local market knowledge - from a number of different Indian companies.

Government policy

All formal collaborations have to be approved by government, in which sense, government actions are a crucial determinant of the number of collaborations. As with other policies, government actions on foreign collaboration can therefore be described as opening or closing a 'gate'. But for the level of collaboration and investment to increase, foreign and Indian firms must also want to collaborate, and this will depend on their perceptions about the policies currently operating and about the other factors mentioned above.

There have been no obvious changes in the basic framework of foreign collaboration policy to help explain the increase in software-related collaboration in the late 1980s. As described in chapter 2, collaborations in the IT field were encouraged by the government in the 1960s but the subsequent perceived lack of control and benefits in this and other industries led to the introduction of the Foreign Exchange Regulation Act (FERA) in 1973. Since then, the basic framework of a 40% foreign equity limit in India-based firms, relaxed to 100% for wholly export-oriented ventures, has remained the same.

What has, however, changed during the 1980s - and this should be seen as being a 'liberalisation' - is the attitudes and procedures that relate to foreign collaborations and investment[10]. Government officials dealing with the electronics industry welcomed foreign companies, even to the point of favouring local initiatives with foreign collaboration (GoI 1987d), and stated that the aim of policy was 'to build up trust in the minds of the foreign companies' (Malhotra 1987). There were Prime Ministerial visits overseas to encourage foreign investment in India (Bobb 1988, Gopalakrishnan 1990), which can be contrasted with the lack of encouragement in the mid-1970s (GoI 1975a:36).

The bureaucratic procedures may still be lengthy and so discourage some foreign firms (Rayner 1989, Thakurta 1990) but for others, including Citibank and Texas Instruments and DEC, the changes were the trigger to enact long-held plans for investment and collaboration.

Related legislation has also affected collaboration decisions. As described in previous chapters, import liberalisation was part of the process in the setting up of software and hardware distribution agreements, while continued protection from complete system imports has encouraged foreign suppliers to set up production within India. Government procurement policies have further encouraged this by helping to fuel a rapid expansion of the domestic market.

Copyright legislation was a necessary step before software suppliers were willing to set up distribution agreements (Schware 1989:25). Without the provision of a certain level of infrastructure (electricity, water, telecommunications) and the alteration of several communications regulations (Poe 1987), wholly export-oriented software firms would not have been set up by foreign companies. Similarly, the provision of skilled and qualified labour, which has been a major government responsibility, encourages foreign investment (Schware 1989:61).

These and other policy measures have probably had some effect on decisions about the type of collaboration undertaken. For example, without the special policy incentives available to wholly export-oriented firms - 100% foreign ownership with hard currency accounts and full profit and dividend repatriation, duty-free and almost bureaucracy-free import and export - and without the explicit confirmation of their application to software in the mid-'80s, it is unlikely that the investments in multinational subsidiaries (COSL, TI, etc) would have taken place.

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[10] Such changes in legislation and implementation to encourage foreign investment have been seen in most developing countries since the mid-1970s (Page 1987).

Yet, in other ways, policy may have had less effect on the form of collaboration than might be imagined. For example, the FERA rules place limits on foreign ownership, but there are arguments that corporate strategies changed away from total ownership towards joint ventures and management contracts in the 1970s, and that these new forms of collaboration would have appeared anyway from the late 1970s onwards, with or without the FERA legislation (Page 1987, Martinussen 1988:187, Enderwick 1989:15).

Similarly, the government has imposed export obligations on hardware joint ventures (Economic Times 1985b, Computers Today 1987d). Although this has encouraged such firms to modify their structure in order to export software, it is likely that they would have done so anyway because of the benefits that such exports bring to the foreign partner's overseas hardware sales.

Some writers, such as Page (1987), feel that government policy has not been decisive in guiding collaboration decisions, but others (EPW 1984a, IDC 1988a:E1) do see a link. In this particular case, it seems likely that government policy has had some impact on both the level and form of foreign collaboration. The deliberate restrictions on multinational involvement and investment, and other procedural controls probably do discourage some investment (Martinussen 1988:193-97) and make more detached forms of collaboration more likely. Equally, however, liberalisations in the form of attitudes, incentives, procedures and import policy have encouraged closer collaboration and greater investment.

However, there is no simple relationship between policy liberalisation and foreign collaboration because deliberate state interventions - to protect local production from some imports, to procure IT goods, to set up infrastructure, and to legislate on copyright - have also encouraged collaboration and investment.

Summary and conclusions

Software trade provides foreign firms with access to the Indian market for their goods and with access to cheap, skilled Indian software labour for services exports. However, these firms have turned to collaboration because it can provide more. In particular, it can provide important elements within relationships between consumers and producers that cannot be satisfied by open trading.

Firstly, collaboration provides for the addition of local services to these firms' goods in order to improve their penetration of the Indian domestic market. Secondly, collaboration provides an assurance of access and control over skill, production and product quality in software exports which, in turn, permits greater cost savings through offshore work.

Added to this has been pressure from Indian software firms, which need to collaborate in order to export and which want to collaborate in order to increase domestic market earnings; and encouragement from the Indian government through a provision of inputs and incentives which it has been able to introduce without disturbing the framework of foreign collaboration policy.

The reasons for investment (as opposed to just collaboration) in hardware production in India - low costs, improved sales control, avoidance of import duties - were covered in chapter 6. The mobility of Indian software labour means that such reasons do not apply to direct investment for software production. This investment seems to come mainly because of the greater assurance about access, about understanding of corporate needs, about skills, and about control (and, hence offshore cost savings) that this very close type of collaboration can bring[11].

Relatively liberal policy (both written and procedural) on such investments has been a necessary step but it is not clear whether it has positively encouraged investment. Without further research, it is impossible to disentangle the relative causal weights of changes in government policy, changes in the macroeconomy, and changes in multinational corporate strategy.

All that one can conclude is that foreign collaboration policy liberalisation, but also government interventions, have encouraged foreign collaborations and that liberalisation has been a necessary part of the growth of certain investments. However, there are also non-policy reasons underlying the growth in collaboration and investment, and even 'policy' in this case has been taken in a very broad sense to be not just written policy and policy implementation, but a whole range of actions by government officials.

The factors described here are also a reminder that far more than just cheap labour goes into explaining the internationalisation of production. If labour costs were of overriding importance, one would expect, as predicted by authors such as Rada (1980a:88 & 1980b) and Frank (1981), that multinationals which had set up production in India would relocate if other locations with cheaper labour costs appeared, or would relocate back to developed countries if production became automated.

Yet, despite the availability of cheaper labour in other Asian countries (Kaplinsky 1987:16) and despite the growing automation of software production (see chapter 5), there has been no relocation of software or hardware production from India during the 1980s. This is because relocation is a costly exercise (Ernst 1985:343) and because

[11] Though it is clear that such foreign firms also hope to gain access to the domestic software market (Dataquest 1989i, Dataquest 1990w).

considerations about skills, client-developer trust, access to the local market, and government policy have been just as important as those about labour costs[12].

3. Implications of collaborations

Given that the level of software-related collaborations and investment rose dramatically within India during the 1980s, an assessment needs to be made of the effect of these changes on the firms concerned and on the industry as a whole, considering both quantitative and qualitative impacts.

3.1. Software packages

Most of the implications of collaborations involving software packages have been discussed in previous chapters and so will only be briefly reprised here.

Distribution collaborations relating to software package sales in the domestic market have helped to bring the latest versions of software to India along with related awareness, skills and training aids. There has been indirect foreign investment through training, provision of free or cut-price technology to the distributors, and in the discount on all products sold. The gross revenue of the Indian companies has increased through both package sales and related sales of domestic software services.

However, there has been no direct investment associated with these collaborations and most of the package revenue generated goes to the foreign supplier. Through the local distributor, these suppliers have encouraged a certain form of consumption within the Indian market, geared towards software products that have been produced for developed country consumers and needs. These sales both rely on and reinforce the preference for foreign goods among Indian consumers (Verghese 1986, GoI 1987e). There has been no attempt to pay for modifications to suit particular Indian needs and the development of all India-specific packages has been quite independent of any collaboration.

A limited encouragement of local software package development by foreign imports has been more than matched by a reduction in the ability of local firms to compete in the domestic market and a lack of transfer of 'know-why' which can be used as the basis for subsequent innovation. As a consequence, there has been a reduction in the overall extent

[12] Page (1987), Sayer & Morgan (1987), Elson (1988) and Wield & Rhodes (1988) also conclude that the 'cheap labour' hypothesis is far too simplistic and that relocation is less likely to occur than previously thought.

of technological capability and, for certain software technologies, a dependence on foreign sources[13].

Collaborations relating to the sale of Indian-written software packages in overseas markets have been rather few in number. Foreign collaborators have provided the inputs - finance, market information, design and analysis skills, program specifications, marketing, and post-sales support - that the Indian company cannot. The Indian company gains some revenue from sales it could not otherwise achieve, but it typically provides only low-skilled programming services in return for a very small percentage of overall revenue. It is also likely to lose intellectual property rights over the software[14]. Some Indian companies have invested abroad in order to gain more control over, and more revenue from, this process.

Summary

As was seen with hardware in chapter 6, foreign collaborations provide a mixture of benefits and costs, though the absence of collaboration for software package production in India limits possible technological capability gains more than was the case with hardware.

While foreign collaborations can provide indirect investments in some useful qualitative inputs, they have not generally provided Indian companies with direct investments. Nor have they offered the kind of capabilities or level of competence to break away from dependence on foreign skills and technology or from the growth of foreign consumption patterns. Only outside these kind of collaborations has there been any development of packages to match specific Indian user needs or the kind of package export that brings long-term benefits to Indian companies.

3.2. Domestic software services

Foreign hardware companies need a local presence within India partly because some of the software they integrate with their hardware requires local knowledge and local customisation to Indian user needs[15]. They therefore use their local collaborator's staff for custom software development work.

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[13] See also BM (1988).

[14] In some cases, whether it wants to or not. See Computers Today (1986a) and Schware (1989:72-73).

[15] Sayer & Morgan (1987) and Enderwick (1989:22-23) point out that this is a general characteristic of service industries.

Software production is seen as distinctly secondary to hardware-related work because of the opportunity costs. A staff member working on hardware sales will earn about US$40,000 per year in revenue, while moving that staff member onto software production roughly halves their earning potential (Interviews, Dataquest 1989l, Dataquest 1990w). The foreign companies therefore prefer just to sell software packages with their hardware or to subcontract software development rather than expend collaborator staff effort on software development (Narasimhan 1984:29).

The Indian collaborators have been provided with some indirect investment in the form of free or cheap hardware and some limited software training, though of course only 'on software related to the partner's hardware.' (Schware 1989:37), and only to the extent that it helps to sell more computers. Much of this investment has also been more directly aimed at software exports than domestic software development. Thus, relatively little of the technology and skills invested by foreign hardware companies goes to serve the Indian domestic software market.

These collaborations also reinforce the fact that 'at present in developing countries informatics serves the research and academic groups and big business and organized industrial sector' (Narasimhan 1984:82). Important domestic applications outside this area - such as hospital control systems and transportation-related systems - have all been developed by non-collaborating Indian companies. Applications concerned with basic needs and rural development - agriculture, integrated rural development programmes, development planning, irrigation, health care - which should arguably be the 'priority concern of a developing country' (Narasimhan 1984:30), have all been developed through government funding or by public sector companies.

Summary

These collaborations have provided relatively little technology and skills for the Indian domestic market, and what has been provided has been to help sell computers rather than address domestic market needs.

3.3. Software services exports

As described above, there have been three main types of software services export collaboration - loose collaboration with foreign contracting agencies, close collaboration through foreign multinational control of a subsidiary, and a range in between linked to foreign hardware companies. These can be judged in terms of various impacts on the Indian software industry.

Export growth

Collaborations have been a vital part of the growth in India's software services exports, thanks to the way in which they lower marketing, credibility, skill and technology barriers. Collaborations with multinationals account for an average of around three-quarters of all exports in most of the largest software companies, and the figure is much greater if one includes collaborations with contracting agencies. About 40% of exports come from collaborations involving some foreign investment in India and foreign-controlled subsidiaries have all shown particularly high growth rates and have moved into the top ten software exporters within a year of commencing operations.

However, this dependence on the foreign collaborator as a source of export contracts is not always positive. The failure rate among foreign contracting agencies is quite high (Widge 1990), though the relative detachment of the relationship to such agencies means that most Indian companies can recover fairly easily from such failures and initiate a new relationship. Indian companies in closer collaborations may not be so fortunate.

As described in chapter 3, several companies which were major software exporters in the early 1980s have largely dropped out of software exports after their foreign collaborators variously went bankrupt (Systime); decided to change collaboration to a different Indian firm (ORG); or lost interest in India as a source for software exports (Computronics, Shaw Wallace).

Similarly, TUL's fortunes have been strongly linked to those of its US parent company and it has shown a far more variable growth rate than TCS, which has no main collaborator. In 1985, the major US hardware manufacturers 'underwent something of a slump' (Coopers & Lybrand/IDC 1986:105) and in 1989/90 Unisys made a loss of several hundred million dollars (Kehoe 1990). Correspondingly, TUL's software export revenues shrank by 11% in 1985 (a poor year for Indian software export growth in general) and rose by only 5% in 1989/90 compared to much higher overall software export growth, and higher figures for TUL growth in other years. Part of the explanation for the fact that the 1989/90 performance was better than that in 1985 comes from TUL's deliberate attempts to diversify operations away from reliance on Unisys.

Collaboration can therefore bring export growth, but it also brings dependence. Often, the closer the collaboration, the higher the growth but also the greater the dependence and vulnerability.

Type of output

Indian software exporters begin their export 'careers' by undertaking relatively low-skilled, onsite programming. As explained in chapter 4, those who collaborate have the opportunity to move up a 'trust curve' and take on more highly-skilled turnkey offshore work.

Collaborators ought to have an in-built interest in raising the skill levels of Indian workers because it is the higher-level skills which are in shortest supply and which also offer the greatest cost savings. Indeed, in foreign-controlled subsidiaries like COSL, there has been a fairly rapid move to this type of work.

This has not been the case with contracting agencies. By interceding between the foreign client and the Indian company[16], they reduce the opportunity for trust and credibility to build up, and such collaborations remain dependent on 'body shopping'. Foreign hardware companies, too, have been particularly concerned with contracting out relatively low-skilled software maintenance and conversion (see Ernst 1983:90).

Capital Invested

All collaborations involve some indirect investment by the foreign company, at the very least of its managers' and administrators' time. Foreign hardware companies and controllers of foreign subsidiaries have all invested in training of Indian staff, and many have invested by donating or loaning hardware and software tools or by selling them at reduced prices.

A few foreign companies have made substantial direct investments related to the Indian software services industry. However, almost all of the direct investment has been on imported equipment, and investments by most of the hardware companies have been spent mainly on their own computers.

In general, capital has only flowed into the domestic economy to pay for labour, consummables, rent, and inputs such as electricity and water. In wholly-owned subsidiaries, other foreign exchange earned will stay in hard currency accounts and 'have no direct effects on the economic welfare of domestic nationals.' (Warr 1989). Where

[16] Often to the extent that the client is unaware of the Indian company's identity.

there is joint equity, this is not so, but then, software-related investments have also been much lower in such collaborations.

In addition, profits and dividends from any equity invested can be wholly or partly repatriated and the foreign company is permitted to repatriate other capital up to the value of its investments[17]. Bagchi (1990) therefore concludes

> "Foreign enterprises in India have practically never been net importers of capital. ... The key lesson is that direct foreign investment is not investment."[18]

Yet, at the same time, the Indian government has spent money on cash compensatory support, and on subsidies to power, water, transport services and office rental in order to attract this foreign investment into export processing zones[19]. The government also spent more than US$50m on infrastructure and support facilities for the zones up to 1989 (GoI 1990b:122). In return, it has only received revenues through staff income tax and spending on telecommunications[20], suggesting a significant overall deficit in government revenue from these policies.

As such, most of the positive benefits from foreign investment have come from access to technology and technological skills rather than an infusion of foreign exchange into the economy, though the Indian companies or partners have had little choice over the technology and skills they are offered[21].

This is but one part of a wider issue - that foreign collaborations cause Indian firms to lose independence and control over their business activities and directions. In joint ventures there may be differing local and parent strategies, as seen in the case of TUL. However, it can equally be true that despite foreign firms being only minority share holders, their management interests hold sway in the Indian company, with the Indian managers reduced to the role of 'minders' (see, for example, Khan 1990).

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[17] Transfer pricing may also be used but this was not researched in this study.

[18] The latter part is a quote from Krugman (1987:321).

[19] Some government revenue is also foregone as customs duty and tax holidays. However, foreign investors would have been unlikely to come to the EPZ without these, so they do not represent a high opportunity cost as far as foreign investment is concerned.

[20] Warr (1989) estimates that only 4% of gross EPZ benefits come from such earnings.

[21] Coopers & Lybrand/IDC (1986) come to a similar conclusion about foreign investment in the UK software industry.

The loss of control is even more obvious in the case of firms which are wholly foreign-owned because

> "The whole question of how and where resources and skills are allocated and utilised within a transnational corporation is decided on the basis of the parent company's interests, not on the basis of those of the branches or subsidiaries." (Martinussen 1988:183)

Technological capability

Foreign contracting agencies have not generally invested in skills or technology for their Indian collaborators. Foreign hardware companies have sometimes given on-the-job training on new hardware and software to the Indian software developers who work for them, with export contracts sometimes providing access to more up-to-date technology than is available in India.

However, in most joint ventures with hardware companies, there has been little interest in building up innovative software skills because those skills are secondary to serving the interests of hardware. In fact, though evidence was patchy, there were some signs of a greater proportion of higher-level skills in firms with ordinary collaborations compared to those which had been devoted largely to serving the sales needs of a hardware multinational.

Though they have hired a few skilled workers, foreign-controlled subsidiaries have also helped to create new employment opportunities and technological capabilities by training new, entry-level staff[22]. Capabilities include those of awareness about new technologies and methods, and of working with particular computer and software tool technologies, but also higher-level skills of systems analysis, program design and project management, as well as more general Westernised work attitudes. There has been a substantial transfer of skills, standards, and working methods in both software development and project management, to the extent that these 'Indian' companies functioned much like any other department of the parent company.

Innovation has been encouraged and the productivity levels (revenue per employee) of Indian firms with foreign investments have been above the software industry average (Interviews, Dataquest 1989l, Dataquest 1990w). The productivity figures have to be corrected for the much lower earnings of domestic software sales and they are only approximate because of uncertainty about employee numbers. Even so, they do seem to

[22] Indeed, they had to give written undertakings to do this (EI&P 1985c).

indicate greater production efficiency and/or a lower turnround time between export contracts in these multinational subsidiaries. Other software export collaborations have shown much more mixed productivity figures.

As well as helping to raise the capabilities of Indian workers, the foreign-controlled subsidiaries used a greater proportion of offshore working than other firms and so may have helped to reduce the 'brain drain', which is exacerbated by onsite contracting[23]. Other types of foreign collaboration may have helped to act as a conduit for those wishing to go and stay overseas. A number of interviewees, for example, pointed out that TUL had a particularly high staff turnover rate (see also Dataquest 1989k), and so do companies which work with foreign contracting agencies (Lakha 1990).

Links to the domestic economy

There has been a hope that skills and technology from export-oriented foreign subsidiaries would be transferred to the domestic economy (Kumar 1989a:14) but this has not been realised.

> "Administrators of EPZs agree that there have been few significant transfers of technology and skills from EPZ firms to the domestic economy." (Warr 1989)[24]

In fact, as described in chapter 4, whatever the type of collaboration, few skills are transferred from the export-oriented to the domestic-oriented segments of the Indian software industry. The domestic economy therefore remains relatively delinked from the benefits described here.

India has been seen by foreign collaborators, especially investors, as a source of software labour. Other necessary production elements - technology, training, marketing, research and development, work environment - have been provided by the foreign collaborator, and there are few links between domestic firms and the collaborating firm in the form of inputs[25].

There are also opportunity costs to the Indian economy in the type of output into which Indian software labour is being channelled by these collaborations. Collaborations have been geared to using Indian software labour for software exports, so that local skills are

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23 It was unclear at the time of writing if key local workers were being lost to parent company, as suggested as a possibility by Coopers & Lybrand/IDC (1986).

24 The lack of transfers is also noted by Kumar (1988) and Muralidharan (1988).

25 Harrison (1978) and BM (1988) make a similar point about multinationals in general.

harnessed to create software which does not directly benefit Indian agriculture, government or industry, and which instead benefits the performance of foreign firms, some of which are competitors to other Indian companies. This is, of course, a criticism of export orientation overall, but it is through collaborations that this orientation has taken hold in the Indian software industry.

Summary

All software export collaborations must begin by being judged from the fact that they are vital to India's software export growth. If a software industry is export-oriented, as India's has been for much of its existence, then there is little choice but to collaborate.

However, it is worth pointing out, as in chapter 4, the opportunity costs of such an orientation, which leaves many important domestic applications neglected by the major part of the industry; a neglect reinforced by reliance on foreign collaborators that have shown little interest in the development of software for non-business organisations.

Judged from the perspective of the Indian economy as a whole, foreign collaborations have brought little net investment and, when capital, technology and skills have been passed to Indian companies, there has been little choice about them and little transfer to the domestic economy.

Relationships with foreign contracting agencies offer relatively limited prospects for export growth; are associated with a persistent skill and locational international division of labour; offer little in the way of skills, technology or other investments; and may help to increase the loss of Indian staff to foreign companies. Such relationships are the loosest of the three main types of software export collaboration, and Indian software companies attempt to move to other collaborations as soon as they can. Contracting agencies are only used because they provide Indian software companies, particularly small or new exporters, with a way to overcome market barriers.

Many of the larger Indian software companies collaborate with foreign hardware firms. A substantial amount of export work can be provided by such collaborations but they leave the Indian company more dependent on its partner's fortunes and more vulnerable than sub-contracting relationships. The Indian companies are often provided with access to technology and to some skills, but the foreign partner remains in control of these. They also control the type of work contracted out and many have chosen not to move significantly away from onsite programming work.

Thirdly, there are collaborations in which the Indian company is a subsidiary of, and often wholly-owned by, a foreign multinational. In some ways, these collaborations provide the most, yet in others they provide the least. The subsidiaries have experienced high growth and significant transfers of capital, technology and a whole range of skills from the parent company. They undertake highly-skilled work, mainly carried out in India, and they have had relatively low staff turnover rates.

Yet, the subsidiaries are highly dependent on the parent company's financial fortunes and corporate decisions. And, despite the fact that these firms are isolated from the rest of the Indian economy, the Indian government has invested substantial amounts and has liberalised policy in order to attract them.

Stepping into the offices of any of the subsidiaries is like stepping out of India. Technology, work standards, management style, office layout and even staff uniforms replicate those found in corporate headquarters which, thanks to telecommunications links, might just as well be in the next city rather than thousands of miles away. Staff do not need to join the brain drain and go to work in the US because they are already effectively there, having joined an 'internal brain drain'.

In summary, closer collaboration is generally associated with higher export growth and with greater investment in both technology and people. The closer the collaboration, therefore, the more it helps to overcome the persistently low skill-, technology-, capital-, and marketing-intensity identified with much of India's software exports. On the other hand, closer collaboration also begets greater dependence and vulnerability, less choice and control, and fewer links either from or to the Indian domestic economy.

3.4. Political economy

As India's domestic markets have grown, transnational corporations and foreign governments have become increasingly interested in them and, as will be discussed further in chapter 9, have attempted to influence Indian government policy to improve their access to those markets (Datt 1987b:120, Manor 1987). One way in which this is done is by linking this access to the success of software exports from India.

> "Participation in lucrative service markets has been used by one nation as a bargaining lever in its attempts to obtain access to a heavily protected goods market in the service firm's source nation." (Enderwick 1989:215)

Collaborations provide the mechanism for this.

> "It [Indian big business] has to do deals with metropolitan capital in order to enter the international arena in any significant way. But metropolitan capitalists insist on the opening up of domestic markets." (Harriss 1989)[26]

Collaborations have therefore been useful to foreign companies not just because they provide improved access to the domestic economy, but also because they allow a greater influence on the domestic political economy. Large Indian collaborators provide foreign firms with a locally-based group which has common interests and which also has well-established links and influence with the Indian policy-making bureaucracy and other relevant bodies[27]. In some ways, then, the Indian collaborators can be seen as 'Trojan horses' which are present within the Indian political economy but which are encouraging policy changes which benefit foreign multinationals.

This happens in two ways. Firstly, because the Indian firms are aware of the reciprocity between exports and imports. Foreign firms will provide the main export markets for Indian software but, in return, Indian firms will help them gain freer access to India's IT markets[28].

Secondly, collaborations provide Indian companies with a self-interest in policy changes that benefit multinationals. For example, all the Indian companies involved in software distribution deals since 1987 form a lobby in favour of continued software import liberalisation. Similarly, thanks to its distribution agreement with Tata Unisys Ltd, the US software company MicroSoft has been able to exert more effective pressure for action to be taken on software piracy in the Indian market[29].

Companies with wholly-owned Indian subsidiaries get a direct entry into the Indian political economy. These have been lobbying, for example, for greater access to the domestic market though, judging from interviews, the Indian government seems to have provided most of the policy measures which they would like.

Of course, issues of power and influence are not all one-sided. The multinationals are willing to accept certain conditions because of their wish to access India's markets, and

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[26] Summarising the work of Patniak (1986).

[27] Datt (1987b:192) sees similar 'foreign dominance' and 'collusion with Indian big business' in the Indian economy as a whole. Hindley & Smith (1984) also voice a concern about 'interference in host-country politics' by multinationals.

[28] For example, this reciprocity lies behind the TUL representative's description of exports as 'a two way street', when he was advocating some import liberalisations in policy discussions in 1986 (EI&P 1986b). Evans & Tigre (1989) see a similar problem for hardware.

[29] Other foreign suppliers have followed suit, trying to reduce piracy losses in India estimated at US$50m by 1988 (Mehta 1988).

their willingness to take on software exports from India comes from self-interest and direct benefits rather than any other motivation.

Nevertheless, the growth in foreign investment and collaborations brings with it growing foreign influence on Indian government policy, and the reciprocity between exports and imports means that increasing export success may bring increasingly successful pressure to bear for the opening of domestic markets.

4. Conclusions

Growth in collaboration

There has been a significant growth in the level of software-related foreign investment and collaboration in India during the 1980s. There have been many different forms of collaboration, though all have involved at least some indirect investments by foreign companies.

In part, this increase can be put down to the wish of foreign companies to gain access to Indian IT markets and to assure themselves access to and control over high-quality, low-cost export labour which can meet their specific needs. Neither of these can be achieved so well by trade alone and both are important parts of close consumer-producer relations in software.

Indian companies have been encouraging collaborations and so, too, has the Indian government. In chapter 1, a viewpoint of encouraging foreign collaboration and investment was associated with neo-liberal ideas. Here it has been seen that government encouragement comes through a mixture of liberalisation and state intervention, and not through liberalisation alone. This suggests that there is no simple association between the continua described in chapter 1. However, the findings presented here also suggest that liberalisation has encouraged foreign collaborations and played a necessary, though not sufficient role in increasing the level of such collaborations.

The growth in software-related collaboration has also come about because of the intimate link between goods and services, particularly hardware goods and software services[30].

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[30] As seen in chapter 5, there is a similar interlinking between software goods and software services. Rada (1984), Clairmonte & Cavanagh (1985), Correa (1985:49), Quinn (1988) and Gaio (1989:175) all note the goods-services or hardware-software relationship.

Foreign hardware companies have sought links to provide better access to Indian software services, which can act as a lever to sell more goods in both Indian and foreign markets.

This explains the hardware companies' growing interest in, and control of software production (Correa 1985:22-23, Schware 1990a). It also suggests a new form of the international division of labour in which developed country companies continue to produce capital-intensive manufactured goods while developing countries supply linked labour-intensive services.

Costs and benefits

Whatever the nature of the links, there must be careful consideration to weigh up the costs of foreign collaboration against the benefits (Coopers & Lybrand/IDC 1986, Weiss 1988:317, Lakha 1990).

Foreign collaborations have been a vital part of India's software export growth, without which winning contracts would, for most firms, have been very costly, difficult and time-consuming. The marketing and credibility gains that foreign companies can bring may be complemented by investments in capital, technology and skills which provide new jobs and more highly-skilled offshore workers. Some collaborations, such as those involving full foreign ownership, have therefore succeeded in upgrading the pattern of low skill-, design-, technology-, capital- and marketing-intensity of export production.

Managers in many Indian firms have therefore regarded collaborations as positive and developmental, though any such benefits of foreign investment have been restricted to the larger Indian companies, so that investment has helped to reinforce market concentration[31]. Nevertheless, there is support for the neo-liberal view that foreign companies can provide much-needed inputs of capital, skills and technology.

But this has not always been the case because:

> "... it is commonly acknowledged that TNCs do not necessarily provide capital, technology, employment opportunities or access to global distribution and marketing facilities to any great extent." (Martinussen 1988:182)

Many collaborations, and even investments, have only helped to perpetuate the persistent international division of labour that characterises Indian software production.

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[31] Narasimhan (1984:61-62) also points out that small software companies are disadvantaged by collaboration in general.

There are other costs, too, which have been associated with the growth in foreign collaboration and investment[32]. Losses of profits, staff, intellectual property rights and package sales revenue have all been seen in some collaborations and there has been a tendency to focus on India merely as a source of labour rather than as a source of other production inputs.

While there have been relatively few links to or from the Indian domestic economy in export-oriented collaborations, such transfers as exist in domestic-oriented collaborations have been geared to increasing the sales of foreign goods. This use of Indian labour to boost the growth of foreign firms and foreign economies incurs a large opportunity cost when applications to meet many domestic needs are consequently ignored.

Foreign collaborations have also been associated with a loss of self-determination. Individual firms (and, hence, the whole industry) fall victim to the weakness and vulnerability that come with dependence on foreign firms for markets, technology and skills[33]. Many are in a relatively weak bargaining position and they have been offered little choice over what contracts, what technology and what skills they are given access to.

There is a wider aspect to this in the growing foreign influence over Indian policy making. Through their links with Indian companies, through their Indian subsidiaries and through the reciprocity between software exports and IT goods imports, multinationals have become a much more significant part of the Indian political economy in the late 1980s and their presence is likely to constrain future policy choices.

There is therefore also some support for the dependency perspective as described by Weiss (1988:42). Foreign collaborations help to promote local consumption patterns copied from the developed nations; to promote a trade of services from a developing country in exchange for goods from a developed country; and, through hardware and software tools, to bring a greater capital-intensity of production. In order to attract the best Indian staff, multinational-linked companies have tended to pay more than the 'going rate' and so drive up wages. This has helped to create a software 'labour aristocracy' and to increase existing income inequalities within India.

In conclusion, while multinationals may have been the main beneficiaries of internationalisation (Clairmonte & Cavanagh 1985), they have not been the sole beneficiaries. The Indian software industry and other parts of the Indian economy have

32 Coopers & Lybrand/IDC (1986) list many of the costs.
33 See also Verghese (1986).

benefited from collaborations, especially in terms of quantitative growth. However, the resources provided by collaborations have also led to increased dependence on external sources of technology, skills and market access, and to a loss of self-determination. As pointed out in chapter 6, there can therefore be no simple, polarised view either 'for' or 'against' these collaborations.

Policy

In chapter 6, and to a lesser extent chapter 5, the impact of imports and collaborations on import-substituting production was discussed. The argument put forward was that liberalisation was forced on the Indian government in software goods, but that the government had fairly successfully steered between liberalisation and protection as regards hardware.

With software services, there was an early orientation to exports created partly by state policy and partly by the nature of the markets involved. This has meant that little steering was possible over foreign collaboration because, for the industry to grow, encouragement of collaboration was necessary.

> "An export-oriented industrialisation strategy cannot be effectively pursued without co-operation from TNCs" (Foley 1989:11)[34]

Although policy has been only one element of the foreign collaboration equation, it has played an important role, and one may therefore agree with Martinussen (1988:184) that 'regulation cannot be reduced to limiting TNC activities as much as possible.' but should aim to induce the TNCs to produce 'a higher degree of internally-oriented economic development.' In other words, the government should seek to minimise costs and maximise benefits while still allowing collaboration to continue. It must therefore 'manage the ties' with multinationals as it did with the hardware industry in the 1970s (Grieco 1982)[35].

For example, by placing greater controls on foreign entry into the domestic market than on entry into software exports, the Indian government has recognised the different requirements of different technologies and industrial strategies. The government can also partly influence the type of collaboration undertaken and, in the light of the industry strategy chosen, it can assess which of the three main forms described provides greatest benefit for least cost.

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[34] Martinussen (1988:206) also comes to this conclusion.

[35] And as did both South Korea and Taiwan (Evans & Alizadeh 1984).

In conclusion, Weiss (1988:318) would seem to be correct in arguing that there can be no overriding policy for or against foreign investment (and collaborations). There is a need to weigh up costs and benefits of different forms of collaboration in the light of existing industrial capabilities, the type of technology being used, political constraints, and national priorities, but overall to try to promote those collaborations 'that foster rather than constrain indigenous initiatives.' (Evans & Tigre 1989).

The government can act to strengthen the bargaining position of local companies (see Chudnovsky 1981, Martinussen 1988:201, Schmitz & Hewitt 1989). Although in other circumstances this strengthening might ideally occur prior to a growth in foreign collaboration, it could also occur as part of a greater balance between domestic and export production of software services; a strategy already recommended in chapter 4.

In these circumstances, positive government intervention would seek to encourage indigenous research and development, to boost market growth for local production, and to substitute for the inputs that foreign firms provide (see Bienefeld 1981:91 quoted in Weiss 1988:164-65, and Kumar 1989a:15). In chapter 8, it will be argued that the Indian government has attempted to do just this, particularly during the latter half of the 1980s, and has sought to provide an alternative source for some of the benefits that collaborations bring without having to incur so many of the costs.

CHAPTER 8

GOVERNMENT INTERVENTIONS

Introduction

In chapters 3 and 4, a number of barriers and constraints were described which affect both domestic and export markets for Indian software. Partly as a result of these constraints, domestic and export sales of software services have persistently been associated with a low level of skill-, technology-, capital- and marketing-intensity, while software package sales have been very limited and sometimes of relatively poor quality.

The Indian government has recognised these constraints, most of which are associated with production inputs, marketing and market size. Given that the Indian software industry has had great difficulty overcoming the constraints by itself, the government has also recognised two main methods for attempting to overcome them. The Indian software industry can look to multinational corporations to provide the necessary inputs and markets, and/or the government itself can attempt to provide them. From the policy description in chapter 2, it can be seen that the Indian government has followed a 'twin-track' approach by using both multinationals and itself as a source.

While chapter 7 described the role of the multinationals, this chapter focuses on government actions that attempt to overcome the constraints facing the Indian software industry. Thus, whereas previous chapters have been initially concerned with policy liberalisation, this chapter's primary concern is an evaluation of certain government interventions. Of particular interest will be software-specific interventions, many of which have emerged or been strengthened since 1986.

It will be argued that these interventions have involved delays, misunderstandings and inter-agency disagreements, but that they have been responsive to this particular industry's needs, and that they have been iterative - always trying to improve in the light of past experience and changing circumstances. Thanks to economies of scale, the state can be an efficient provider of some inputs but the complexities involved are too great for this study to provide a satisfactory resolution of the question as to whether it is best to let the state, national capital or foreign capital intervene.

What will, however, be argued is that many of these government responses are a viable alternative or complement to sole reliance on multinationals. They avoid many of the costs outlined in the previous chapter while, at the same time, helping to redress the balance between export- and domestic-oriented production, and helping to infuse capital, skills, infrastructure and additional demand into this industry. It seems highly unlikely that any other source could have fully substituted for these government interventions, which have therefore been a necessary part of the Indian software industry's development. Liberalisation is therefore not the only prescription for industrial development and indeed may, as also described in chapter 7, go hand-in-hand with interventions.

1. Constraints to be addressed

Before proceeding, it will be useful to review the nature of software industry development constraints, identified in previous chapters, to which the Indian government has addressed itself.

Finance

During much of the 1980s, Indian software companies have had difficulty obtaining various types of capital, the most important of which are described below[1].

Start-up capital

Although software companies can be started with relatively little capital (Schware 1989:74), even in the late 1980s such capital was difficult to obtain, with most financial institutions agreeing with the comment of one banking executive - 'We will not give money to completely new start-ups'.

Capital investments

> "Software is moderately capital intensive and very highly technology intensive." (Cleetus 1984a)[2]

Per capita investment levels in the Indian software industry in the late 1980s ranged from around US$1000 for 'body shopping' firms which have only a one-room office, phone and fax, to nearly US$10,000 for those undertaking offshore development[3]. The expense of

1 Mehta (1988), Quinn (1988) and Schware (1989:38,77) also describe software industry financing problems.
2 Kanodia (1990b) also highlights software development's capital intensity.
3 Figures calculated from GoI (1988b), GoI (1989c) and Kanodia (1989). Average investment was just over US$4000 per head (calculated from Mukhi & Chellam 1988).

purchasing equipment and servicing high interest rate loans (EI&P 1985b) has helped to maintain the low technology-intensity of much of India's software production, though loans are relatively easy to come by because they are secured against the value of the equipment.

Working capital

Working capital finances software development, market entry and maintenance work, mainly in the form of labour costs. It is particularly important to software companies, which have a lot of capital invested in incomplete products and projects (Kanodia 1990b). With financial institutions unwilling to accept their software as collateral, even though capital is sunk into its production, and with their capital goods already secured against investment loans, software companies had great difficulties obtaining working capital during the 1980s[4].

Venture capital

Venture capital has played an important role in the development of some Western software companies, yet has been unavailable for Indian software companies during much of the 1980s, inhibiting entrepreneurship and innovation (Raman 1985, Schware 1989:77).

Summary

Small firms have been particularly affected by the problems of access to finance since, unlike the largest companies, they do not have access to capital from multinationals or the large Indian industrial groups[5]. A wide range of firms has chosen to be largely self-financing and has therefore accepted a slower growth rate than might otherwise have been achieved. This, in turn, left much of the industry undercapitalised and underfunded (Computers Today 1986c); has made it hard for any companies to undertake software package development; and has encouraged onsite working (Nasscom 1990a).

Skilled labour

There has been widespread agreement that the single most important input to the software production process is skilled labour, but equally that the relative lack of such skilled labour is the most serious constraint to the Indian software industry's development (IDC 1988a, Singhal 1988, Kohli 1989b, Pawar 1989, Tandon et al 1990)[6]. Although there

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[4] See also Schware (1989:77).
[5] See also Schware (1989:77).
[6] Kopetz (1984:8), O'Connor (1985) and Schware (1989:59,73) note this as a problem for all developing country software industries.

is a shortage of all types of labour, it is the shortage of the higher-skill levels - program designers, systems analysts, project managers - that has particularly affected this industry (Kopetz 1984:20, EEPC 1985, EI&P 1986b, Kumar 1988, Ernest-Jones 1989, Widge 1990).

The result has been a persistence of programmer-only contracts; a level of growth lower than that which would otherwise be achievable; the poaching of staff from other software companies; and the use of underskilled labour, especially for India-based production, so that the software produced can be late, of poor quality, and not adequately matched to the user's needs. With the priority given to software exports, domestic-oriented production has been particularly affected (IDC 1988b, Muralidharan 1988).

A related issue has been the level of research and development within the Indian software industry which, like that of much of India's industry, has been relatively low. As such, opportunities have been missed to develop local technological capabilities and new software products.

Industrial Infrastructure

Necessary elements of any industrial infrastructure include power, water and transport, but of more specific interest to the software industry is the provision of a telecommunications infrastructure; 'the central transport network of the world information economy.' (Feketekuty & Aronson 1984)[7].

For much of the 1980s, this was in a poor state.

> "Communications in India are best not described. With perhaps the world's most archaic, inadequate, overloaded and inefficient telephone system you can safely forget about facsimile, networking, electronic mail or any kind of integrated services for quite some time to come." (BusinessIndia 1986)

Software companies in the 1980s, especially exporters, faced a number of telecommunications problems, including the scarcity of actual telecommunications links, delays in obtaining such links, poor transmission quality, and the high cost of installation and use.

[7] Narasimhan (1984:81) and Rada (1984) also underline the importance of telecommunications to software industries.

As a result, overall growth of Indian software exports has been stunted, and offshore software development has been viewed by most foreign clients as unacceptably problematic (Elsoftex 1988).

Market Information

> "The ability to monitor and interpret market and technical changes and spot opportunities and shift strategy is vital but beyond the capacity of most individual firms" (Sridharan *1989*)[8]

This is one of the major reasons behind the virtual absence of software package exports from India, though lack of market information also makes it hard for software service companies to locate clients or assess potential partners, and for all companies to keep up with the latest software production technology.

Marketing

Marketing was seen by a number of software export companies as their main problem[9]. It is costly and time-consuming to raise awareness and credibility through the kind of extensive, personalised marketing that sales of software services require (Kohli 1989b)[10], and it is even more costly to market software products overseas (Coopers & Lybrand/IDC 1986). Marketing is also a skilled activity (Kanodia 1990b). Most Indian companies lack these skills and cannot afford to spend much on marketing, which severely limits their growth potential.

Market size

The problem for Indian software exporters has been marketing to win a share of the global software market rather than the total size of that market. However, in the case of the domestic market, especially that for software products, overall size has been a significant constraint to company profitability, investment and growth[11]. The size of the domestic market for local companies is determined by the overall value of consumption, the balance between imports and indigenous goods, and the balance between legal sales and piracy.

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[8] This need for market monitoring and information is stressed by Kopetz (1984:15), O'Connor (1985), Schware (1989:61-62) and Roy et al (1990).

[9] See also Schware (1990a).

[10] Marketing costs at least US$5000 for a short overseas visit (of which three or four are needed before contracts will emerge) and US$50-100,000 or more to run an overseas office for a year.

[11] UNIDO Secretariat (1983:22-23) and Fialkowski (1990) agree on the constraint of small domestic market size for software growth.

1.1. Summary

These, then, are the major constraints facing the Indian software industry, in addition to which there has been a problem of access to new technology, as already discussed in chapter 5. The main outcomes of these constraints have been slower growth than might otherwise be achieved and a persistence of the international division of labour described, of the focus on services rather than packages, and of export- rather than domestic-oriented production. Small firms have been particularly affected because of a lack of access to finance which could have helped bring access to better skills, technology, telecommunications and marketing.

In chapter 2, there was a brief description of government interventions regarding finance provision, skills training, the funding of local software research and development, infrastructural provision, export marketing assistance, and software procurement and protection. These interventions have been a response to all of the constraints listed above and they will be discussed in greater detail below.

Each of the sections that follows deals with a particular constraint and looks at government responses to that constraint and at the impact or outcome of those responses. There will also be a consideration of the role played by the only significant public sector software company - CMC - which has been the product of various government interventions.

2. Finance

2.1. Responses to financial problems

Since the 1970s, the government has assisted the financing of growth from profits through tax exemptions on software export profits, depreciation of assets, deposits for investment in new assets, capital expenditure on research and development, fees for know-how, new industrial undertakings, various travel and employee costs, welfare fund contributions, and entertainment expenses (Seepz 1987, ExIm Bank 1988b). However, as already described, this has not been an adequate source of funds for reinvestment.

In 1987, as part of the previously announced software policy, the government-owned Export-Import Bank (ExIm Bank) and Export Credit Guarantee Corporation introduced a scheme of loans for computer systems import, and extended to software schemes for financial support for marketing, pre- and post-shipment credit and export credit guarantees (ExIm Bank 1989b)[12]. The ExIm import scheme is relatively quick because it has a group dealing specifically with software; because it has a 'blanket' foreign exchange permit; and because the bank assists in obtaining government licences and associated working capital (ExIm Bank 1989c).

In November 1988, the Reserve Bank of India (RBI) issued a set of guidelines covering time and cost limits, funding criteria and payback periods for working capital for software services and product customisation (Polavarapu 1989a). Then, in the 1988/89 budget, an RBI/Finance Ministry framework and criteria for venture capital funding were announced; aimed at small, relatively high-risk, technology-oriented projects; providing a mixture of unsecured loans and equity over a seven-year project period; and requiring payback only if the firm was successful (Interviews, ICICI 1988, GoI 1989b:50).

Financial institutions responded to these measures. Some expanded existing working capital funding schemes to cover software in the late 1980s and others set up new venture capital schemes which took in software as one of their funding areas[13]. It has been up to individual financial institutions to interpret the government's broad guidelines on working and venture capital. These institutions make independent decisions and they are influenced by their own perception of software production as an area of financial need and potential profit. But they are also publicly-owned and are strongly influenced by government guidelines and by the government's prioritisation of the software industry.

2.2. Impact of new financing activities

What has been the influence of this new financing on the problem areas already identified?

New and small firms

Despite the new measures, most finance provision has favoured the large, well-established companies. Because software is intangible and hard to value, financial institutions fall back on assessing a company's track record and reputation rather than the likely worth of the project (EI&P 1988c, ExIm Bank 1989b). Lengthy appraisal procedures and

[12] The interest rates on shipment-related credit were also steadily reduced, to about 8% in 1989 (GoI 1989b:127).

[13] For example, in 1988, the Industrial Credit and Investment Corporation of India (ICICI) created a new organisation - the Technical Development and Investment Corporation of India (TDICI) - to take charge of venture funding, management assistance and technology counselling for small firms, including software producers.

minimum funding limits also disadvantage small companies (Vasuki 1989). The only exceptions have been TDICI's venture funding and ExIm Bank's marketing grants, an increasing amount of which went to new, small software companies in the last two years of the 1980s.

Capital Investment

By mid-1989, ExIm Bank had disbursed about US$7m in loans for computer imports to ten software companies, and had sanctioned the loan of a further US$10m, making software one of the bank's largest finance programmes (ExIm Bank 1988a and 1989a). The scheme has undoubtedly encouraged more hardware importation than there might otherwise have been (Interviews).

Working capital

The ExIm-administered marketing grant scheme uses World Bank money to grant 50% of the cost of software export marketing activities (Mehta 1988). Up to mid-1989, about US$3m in grants had been disbursed to over 30 software companies, including a number of small ones, with a further US$3m sanctioned (ExIm Bank 1988a and 1989a). The finance would appear to have been of considerable help to these firms, a number of which stated that they would have had great difficulty marketing their services overseas without it. As reported in chapter 4, the shipment credit schemes have proven similarly useful.

The 1988 RBI guidelines on software working capital appear to have been less successful since the banks have been left free to devise their own working practices (Polavarapu 1989e). A few banks have been willing to take personal guarantees from company directors instead of collateral and will fund on a one-year, renewable basis against an existing order. Most banks, however, have continued to treat software like any other industry and have demanded collateral against working capital loans (Polavarapu 1989a).

Venture capital

Up to mid-1989, just under US$1m of venture capital had been disbursed by TDICI to five software companies - two well-established and three new ones (Interviews)[14]. Soon after that date, the Industrial Development Bank of India and the finance capital divisions of Canara Bank and the State Bank of India also began investing venture capital in software firms. These institutions have found software development particularly suitable for such

[14] This amounted to about 10% of TDICI's total venture capital investments. See also Murthy (1988) and Skaria (1989).

financing because it involves high risks, new products and technologies, but also the potential for sizeable profits. The money has been used for product development, market analysis, marketing and for both salaries and equipment. Those software companies which had borrowed were very positive about the scheme - as one managing director commented, 'We could not have grown as we did without it.'

Goods and services

Many of the schemes described have reinforced the tendency for companies to focus on software services rather than products. For example, Exlm Bank funding guidelines and RBI working capital guidelines are explicitly aimed at software services and not package development (Exlm Bank 1989b, Polavarapu 1989a). The only exception has been venture capital, almost all of which has gone into package development, mainly for the domestic market[15].

2.3. Summary and conclusions

Most of the measures described here were only introduced in 1988 and 1989. With growth and change still considerable at the time of writing (for example, over the implementation of working capital guidelines), and with such a short impact time, any assessment should be seen as tentative.

At the end of the 1980s, the Indian software industry's access to finance, particularly working capital, remained problematic but the situation was much improved compared to that of the early or even mid-1980s. It was still hard for small, new companies or for those developing packages to access finance but the increasing use of venture capital funding was changing this.

Industry growth has been supported by the additional funding of marketing and capital investments, and by the provision of new schemes in export credit, insurance and, as mentioned, venture capital. As a result, firms have become more willing to finance growth through external funding rather than just internally-generated capital.

By 1990, the two most positive influences on software industry financing had been the Exlm Bank and ICICI. Despite deficiencies, their combined efforts had helped to overcome export marketing barriers and to improve the possibilities for offshore working, package development and small firm growth. Though these financial institutions will help to guide

[15] For example, it was used to fund the conversion of a suite of programs from MS-DOS to Unix.

companies in financial difficulties, they have not compromised the independence of Indian software firms in the way that multinational capital has and venture capital particularly has ensured a genuine flow of investment to boost domestic-oriented production.

The government does not directly control the flow of finance to the software industry. It has had to rely on guidelines and the encouragement of certain activities, and its influence has been stronger in organisations like ExIm Bank than in those like ICICI. However, state interventions through policy directives and actions have clearly helped to expand the size and scope of finance provision to the software industry, which has brought the benefits already described.

3. Skilled labour

This section considers firstly the policy responses and impacts relating to general computing skills, and then looks at later, more specific responses and impacts relating to the software industry.

3.1. Government responses to computing skills shortages

Since the significant growth of indigenous software and other electronics-related industries in India in the 1970s, the Indian government has recognised the need for greater supply of skilled labour. Computer science MTechs (two postgraduate years) and BTechs (four years from school) were first started in 1974 and 1977 respectively, and produced about 100 students each by 1980 (EI&P 1982, EI&P 1985d). In the same year, the Rajaraman committee reported on training needs and, as a result, there was an expansion of existing M/BTech courses. Two new courses were also initiated in 1982 - a more practical, vocational three-year Master of Computer Applications (MCA) and a Diploma in Computer Education (DCE) for computing teachers (EI&P 1982, EI&P 1985d, Singhal 1988).

The Rajaraman committee's estimate of training needs 'proved to be on the low side' (Zindal & Chaturvedi 1987) with the result that a Computer Manpower Development Programme was launched in 1983 (EI&P 1984a). This led to the creation of a one-year Diploma in Computer Applications (DCA) for post-BSc graduates in 1984 (EI&P 1985d)[16].

In the same year, the Sanpath committee reported on training needs (Singhal 1988), and in 1985, there was a meeting of all relevant ministries to plan future actions on

[16] This was followed in 1985 by an 18-month polytechnic-based DCA for engineering diploma students.

electronics-related training (Zindal & Chaturvedi 1987). These set in motion procedures which have subsequently encouraged a continuous expansion of all the courses described here and the initiation of some new ones. By 1987, the known output figures were as shown in table 8.1.

Table 8.1

1987 output from Indian computer training degrees

Training course	No. of institutions	Yearly output
PhD (computing-related)	20	20
MTech (Computing)	22	400
BTech (Computing)	30	900
MCA	28	600
Post-poly DCA	37	1250
Post-BSc DCA	48	1250
Hindi DCA	12	
DCA teacher training	10	
MCA teacher training	2	
Programming Assistant/Data Entry Operator certificate	50	2000

Source: EI&P (1987), GoI (1987c), Zindal & Chaturvedi (1987) and Hebbar (1988).

By 1989, over 9000 'graduates' were produced by such courses from about 300 institutions (Dataquest 1988h, Lakha 1990) with roughly 70% of these institutions having been initially brought into the Computer Manpower Development Programme by DoE grants (Dataquest 1988h). In 1989/90, for example, the DoE allocated just over US$2m to initiation of computing and electronics courses, including teacher training, at selected universities and colleges (Dataquest 1989e).

The Ministry of Education actually funds most of the courses and the role of the Department of Electronics has been more to develop curricula, to initiate demonstrator and pilot schemes which encourage the setting up of new courses, and to offer advice on how to run such courses. Some of the education-related ministries at state and central level have been more directly involved in course implementation but, as was the case with finance, the final decisions about implementation remain those of the individual educational institution.

3.2. Impact of general responses

Government-assisted provision of qualified computing-related labour has continually expanded since the 1970s and has helped to provide the skills necessary for industrial growth. However, the provision has always lagged behind demand and has not been sufficient to fulfill overall needs.

> "Estimates of the requirement of manpower in the computer area have been made, and each time a fresh estimate is made, it turns out that the older estimates appear to have been on the low side." (Hebbar 1988)[17]

By 1989/90, it was still estimated that the education system was covering only 60% of computing-related needs (Dataquest 1990u).

Apart from the 'brain drain', there are four main difficulties underlying this. Firstly, there is a limit to the resources that can be allocated to this area (EI&P 1986b, Zindal & Chaturvedi 1987), partly because computer-related training was afforded a relatively low priority until the late 1980s (Bhatnagar 1986). Secondly, there has been a 'long cycle time of two or three years' from the government's recognition of a training need, through planning to implementation of a response (Zindal & Chaturvedi 1987, Malhotra 1989a).

Thirdly, implementation problems crop up because ministerial responsibility for electronics-related education and training is quite widely shared[18]. This has led to a lack of clarity about which body is responsible for particular actions, which can slow implementation. For example, because of this, the 1986 proposal that four Indian Institutes of Information Technology be created still remained unimplemented in 1990 (Malhotra 1987, EI&P 1988a)[19].

Finally, the supply of teachers, especially those with adequate teaching skills, has been a constraint on course expansion throughout the 1980s (GoI 1984a, EI&P 1987, Zindal & Chaturvedi 1987, Hebbar 1988, Kalra et al 1988, Singhal 1988, Kohli 1989b).

Impact on software industry

As with computing as a whole, government-initiated courses have increased the supply of qualified software labour, which has been a necessary part of the software industry's growth, but the supply has not been sufficient to satisfy all of the industry's needs.

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[17] Zindal & Chaturvedi (1987) and Singhal (1988) also note the lag between supply and demand.

[18] The main bodies involved have been the Department of Electronics, the Ministry of Human Resources Development, the University Grants Commission and the Directorate General of Education and Training. State-level education bodies and the Ministry of Labour also make an input and other parts of the Ministry of Education and even the Ministry of Defence and the Ministry of Science and Technology have had responsibilities for some programmes. See EI&P (1987) and Zindal & Chaturvedi (1987).

[19] EI&P (1986b) describes this proposal.

There was a major expansion of the DCA and MCA programmes but these graduates are seen as appropriate for end user organisations, not software companies. 'Manufacturers [of software] tend to prefer B.Techs and M.Techs' (Cleetus 1984a), yet the numbers in these courses were not expanded to anything like the same extent and many of the graduates have left directly to take higher degrees in the United States (Banarjee 1985).

The B/MTech and other courses all tend to provide a basic understanding of computing and software, which is only really sufficient for entry-level software workers (EI&P 1986b, Kohli 1989b). Yet the main bottleneck for the software industry is not for this kind of staff but for those with higher, on-the-job skills of client communication, analysis and project management (Ernest-Jones 1989, Schware 1989:60, Widge 1990).

Government initiatives have therefore produced trainable rather than trained labour. In part, this is because the educational institutions have too few good quality teachers, and use relatively outdated equipment and curricula, teaching on and about hardware, operating systems and computer languages that are not sufficiently relevant to industrial needs (GoI 1987e, Zindal & Chaturvedi 1987, Dataquest 1989m).

In summary, during much of the 1980s, the government tended to focus too heavily on the number of paper qualifications produced - perhaps not surprising since this is tangible and controllable - rather than the correct skill level and quality of output. The need for basic, general software qualifications was addressed, as was the labour supply for end user software organisations. However, the specific needs of the software industry, particularly in exports, were not adequately met. In part this arose because government training policy tended to treat the information technology sector as a whole and not address the needs of individual industries.

3.3. Responses to software skills shortages

It is mainly since the software policy thrust of 1986 that the government began to consider software industry training needs separately from others. Curricula were updated to take account of new software development methods and technologies though, because of the problems already mentioned, this has been a relatively slow process. Several courses were also modified to include work experience in the form of a four-month placement with a software firm.

Policy was altered in 1986 to allow greater freedom to import educational technology and write its purchase off against tax. Aid programmes and government funding have also been used to provide more up-to-date software tools, operating systems and hardware at a number of educational institutions.

Since the 1970s, the DoE-controlled National Centre for Software Technology has run a number of software-specific training courses, mainly oriented towards programming. Much later, it initiated a software project management course, albeit fairly limited in size (NCST 1987). It has also had a role to play in disseminating knowledge about new software development techniques, and it further expanded training provision in 1990 with the setting up of a second centre in Bangalore (Ramani 1990). In the same year, a software development academy was being set up in Bombay to run six-month courses to equip existing graduates with the skills needed to work in software exports (Dataquest 1990t).

Provision of software-related training by private sector training institutions has increased substantially during the 1980s but most of these courses provide only very low-level skills which are of little use to software companies (Kalra et al 1988, Singhal 1988). Nevertheless, the government has recognised the role of the private sector in training and has attempted to work alongside these institutions (Zindal & Chaturvedi 1987, Dataquest 1989m, Dataquest 1990s). After a number of false starts (Dataquest 1987a, Polavarapu 1989c), it was announced in 1990 that a government-sponsored certification programme for private institutions would be initiated (Dataquest 1990x).

3.4. Impact of software-specific responses

By 1990, many of these software-specific measures were only just beginning to take effect. It was already clear that they were helping to provide more; more appropriate; and more high-level software-related skills, and that this, in turn, was helping to address the problems of low-skill or low-quality work. What was less clear was to what extent the new measures were helping to close the software labour demand-supply gap. Because of the continued brain drain coupled with very high industrial growth rates, it was still predicted that the available supply would not meet projected demand in the 1990s (Kalra et al 1988, Pawar 1989, Roy et al 1990)[20]. In particular, government courses were still not providing sufficient training about new software development and management tools and techniques.

Apart from a continuing impact of under-skilled staff being used and a particular skill starvation of the domestic-oriented sector, this also meant that software companies still

[20] Kalra et al (1988) estimated a likely additional demand for 8000 software export staff between 1988/89 and 1991/92, of which only half would probably be met from government-sponsored courses.

had to undertake their own training. Because of the variation in their qualifications and course quality, all new staff were put onto training courses of a few weeks' to a few months' duration, with up to US$5000 per staff member being spent on training during the first year (Interviews, EI&P 1986b). Not only was this very costly for the company but it also seems that equivalent training by state tertiary institutions would have been considerably cheaper (Dataquest 1990t).

3.5. Summary and conclusions

By 1990, it was still too soon to pass conclusive judgement on all the training-related measures described here. Many skills constraints still afflicted the Indian software industry including the demand-supply gap, especially for higher-level skills and for domestic-oriented production, and the necessity for in-house training. Nevertheless, the provision of skills through government-funded and -initiated courses has been a fundamental and necessary part of this industry's growth. The output from such courses has increased from hundreds to thousands during the 1980s and the most productive software companies are heavily staffed by B/MTech graduates.

Despite the fact that not all the output of government training courses goes into industry, the Indian government has shown itself to be responsive to industry needs. These responses have come in an iterative fashion, first helping to increase the size and number of courses as overall demand grew; then focusing on improving curricula and the supply of teachers and equipment as these became problems; and, latterly, offering some courses directed specifically at software industry needs.

The iterations have tended to be slow because they have had to be made within the limitations imposed by resource constraints, planning cycles, the need for multi-agency agreement and action, and by the lack of direct control over educational institutions. Partly as a result of this, educational provision has always lagged requirements and has not yet transformed the international division of labour or the domestic-export skills balance. However, as noted in chapter 4, the demand-supply gap is a global problem and should not be attributed to some particular deficiency of the Indian government.

The shortcomings of government action should not be seen as an indictment of intervention *per se*, but as a guide to more appropriate action. Indeed, given India's relative lack of resources and the need to cope with industrial growth averaging 30-40% per year plus substantial losses of skilled workers settling overseas, the Indian government seems to have responded remarkably well.

Private sector training institutes have not been able to fulfill needs and, as seen in chapter 7, multinationals have had a distinctly mixed record in terms of skills provision, which has been generally beneficial but always geared to their particular technological goals. In any case, neither of these sources would see itself as a supplier of the kind of long-term training needed to produce graduates.

There is therefore a case for a division of labour over skill provision, with government providing large-scale, cost-efficient, long-term education for more generalist, stable skills, while on-the-job training within the industry provides more specific, time- and technology-bound skills[21].

Indian government interventions have been characterised by delays and other difficulties, and interventions by other Asian governments, such as those of Singapore and Taiwan, have (for whatever reason) achieved a closer match between labour demand and supply (Schware 1989:64-66). Nevertheless, the Indian government has been responsive to specific industry needs and there has been no other viable source of the tens of thousands of person-years of training it has provided.

The Indian government's interventions on skills provision and training have therefore been a necessary part of the Indian software industry's growth and it is generally accepted that government-provided education and training must form a part of software industry development (UNIDO Secretariat 1983:22-25, Schware 1989:63)[22].

4. Research and development

In an effort to built up indigenous technological capabilities and to counteract the effect of foreign IT goods imports and collaborations, the Department of Electronics has invested in millions of US dollars-worth of research and development. Almost all of this has been granted to public sector organisations, such as universities and research laboratories. Most of the money has been spent on hardware-centred R&D, though related software has also been developed and there have been specific software investments at the National Centre for Software Technology (NCST) (Malhotra 1987).

The government's funding has helped to maintain software-related skills that imports might otherwise have suppressed, and the software produced includes regional language

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21 Though the Indian government has itself helped to provide job-related skills through work experience placements, NCST courses, and through its procurement policies (see below).

22 A point made more generally by Lall (1987:240-41) and Gaio (1989:174).

word processors, systems software, hospital management systems, and office automation database tools[23]. However, most of the software has been for limited use in the public sector and the R&D has not been commercialised. Research workers rarely leave the public sector and there is a poor level of industry-academia interaction[24]. Some public sector researchers teach on computing courses and there has been a strong combination of software R&D and external training at NCST and, subsequently, at the National Software Centre (NSC). Nevertheless, the technologies and capabilities built up by the DoE's funding have only filtered out into industry to a limited extent.

The government's response to this has been two-fold. Firstly, it has attempted to stimulate private sector R&D through import protection and by offering some tax write-offs for software research and development. This would appear to have had only limited success in stimulating software product R&D (IDC 1988b, Lakha 1990)[25]. In the late 1980s, it was therefore suggested that there would be direct funding of private sector R&D by the Department of Electronics (Hutnik & Jaikumar 1988)[26].

Government policies on education, finance and procurement have also affected local private sector research and development. For example, venture capital funding pays for software product R&D, while government procurement has helped to stimulate local software services development[27].

Secondly, the DoE has initiated technology and capability transfers from research institutions to industry. The first example of the latter, in 1990, was the transfer of design know-how for a parallel processor operating system from the Indian Institute of Science to Wipro Information Technology Ltd (Dataquest 1990z). Some publicly-developed computer-aided design systems have also been provided to consultancy organisations in the engineering industry (Dataquest 1989e).

4.1. Summary and conclusions

With foreign collaborations and imports often more likely to hinder rather than encourage the development of indigenous software products and related technological capabilities, the

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23 Information from DoE annual reports and Dataquest (1990l).

24 See also Alam (1985), Desai (1985) and Wiemann (1987).

25 The same is true of other Indian industries (GoI 1987e, Reddy 1987:219, Swaminathan 1988a). Alam (1985) suggests the need to support R&D results rather than just R&D expenditure and to support informal R&D activities as well.

26 As noted in chapter 6, the DoE also assisted work on modification of the Unix operating system.

27 Policy stability also affects R&D, with frequent significant changes discouraging research and development investment (Ravindra 1987).

Indian government has a necessary role to play in the direct and indirect stimulation of local research and development (O'Connor 1985, Lall 1987:32-33).

Since the 1970s, government funding was aimed at public sector product development but was of only indirect benefit to the major part of the software industry. The government has therefore responded, particularly in the late 1980s, through a system of financial incentives, procurement, funding provision and improved industry-academia links.

As in previous examples, it was too early at the time of writing to offer a full evaluation of these interventions, but they were an improvement on previous measures and a response to specific software industry needs. They have provided a boost to skilled, domestic-oriented production and have often addressed Indian domestic needs in a way that the multinationals and related imports have not.

5. Infrastructure

As noted already, although the industrial infrastructure is made up of many elements, one of particular relevance to software is the telecommunications infrastructure.

5.1. Government responses to telecommunications problems

From the mid-1980s, the Indian government gave additional priority and funding to the telecommunications infrastructure. Although domestic links were still the priority, it was seen that funding overseas links could help companies, especially software companies, to earn foreign exchange. Investment in international links alone was raised from US$150m for 1985-90 to US$200m for 1990-95 and overall spending was intended to rise by 15% annually between 1990 and 2000 (C&C 1988, VSNL 1988). Telecommunications costs were also brought down, at least for international transmission, though in 1990 they were still higher than international levels (Kanodia 1990a, Roy et al 1990).

New telecommunications agencies were also created. In 1986, the old Overseas Communication Service was converted from a sub-department of the Department of Telecommunications (DoT) into the public sector enterprise Videsh Sanchar Nigam Ltd (VSNL). Although wholly owned and funded by the DoT, with government-determined guidelines, it was free to make decisions on spending, sourcing, employment and the like without continuous reference to government, and this has enabled it to become more responsive to industry needs. At the same time, a similar body - Mahanagar Telephone Nigam Ltd (MTNL) - was created to provide local links in Bombay and Delhi (C&C 1988).

Finally, a policy sub-committee was created in the mid-1980s to focus on software export through international telecommunications links, drawing in representatives from the DoE, DoT, VSNL, Defence and Home Affairs Ministries (Dataquest 1987a).

5.2. Outcome of government telecommunications responses

The provision of domestic links continued to grow throughout the 1980s and the problem of line quality was addressed in 1990 by the planning of 'Vikram', an internal packet switching service (PSS) which sends data as digital packets with in-built error checking, rather than as a continuously varying analogue signal. However, the greater progress has been made on international links.

Between 1984 and 1985, the sub-committee mentioned above thrashed out the many alterations to regulations which permitted the use of international telecommunications channels for software export (Computers Today 1985d). In 1987, the Texas Instruments subsidiary became the first to install and use a satellite earth station for software import and export, as well as for voice, fax and electronic mail transmission (Poe 1987)

Other companies were free to follow suit, but such high cost, high volume, point-to-point satellite-based links require a substantial investment and a stable, long-term relationship with a client willing to guarantee a substantial amount of offshore work. Most software companies required a lower cost, more flexible type of link.

In March 1989, therefore, an international PSS link was created by VSNL in Bombay with links gradually expanded over the following year to Madras, Delhi and Bangalore (Dataquest 1989f). For most companies, the weak link in the chain has been the local line connecting their own offices to this system, though this was overcome for companies in Bombay's export processing zone by the provision of a microwave link to the IPSS gateway. This IPSS link transmits relatively slowly, but it is relatively cheap both to install and use, and it provides access to a global digital network.

By mid-1990, there were at least eight firms using such links either for electronic mail or for remote, real-time access to their client's mainframe overseas[28]. As discussed in

[28] See Dataquest (1989s), Dataquest (1990j), Dataquest (1990k), Dataquest (1990w), Kanodia (1990w) and Tilley (1990).

chapter 4, this has allowed Indian firms to win more export contracts and to increase the amount of offshore export work that they undertake.

Later in 1990, the access to international digital communications links was extended to Pune and Bangalore. In both of these a 'software technology park' was created, based around a digital link to the IPSS gateway in Bombay and, by the end of 1990, 32 companies had set up operations in these 'parks' (Dataquest 1990p, Dataquest 1990aa, Lakha 1990). Thanks to shared use of the link between a number of companies and the economies of bringing operations to a single site, the costs of this link were relatively low.

Finally, the expansion of international telecommunications links has also allowed a rise in the use of fax (Dataquest 1988f, Dataquest 1989n, Chowdary 1990). Most software exporters now have a fax, which is used to improve their abilities to win contracts and maintain communication with overseas client sites.

5.3. Other infrastructure

There are many other infrastructural elements of relevance to the Indian software industry that the government has been instrumental in providing. As already described, it has invested substantially in the land and buildings for the export processing zones and the software technology parks, and has provided these with banking and canteen facilities, and with electricity, water and transportation links.

It has also created various support agencies including the Department of Electronics itself; the National Centre for Software Technology and the National Software Centre; and the marketing and telecommunications bodies mentioned in this chapter.

In the 1970s, the government set up a series of Regional Computer Centres, with computers for shared use by academic and industrial users but these were never used to any significant extent by software companies (Interviews, GoI 1975a:57). Other than this, the Indian government has not attempted to intervene directly to overcome hardware and software technology constraints. Relevant indirect interventions were discussed in chapter 5.

5.4. Summary and conclusions

Because of the high costs involved; because of infighting between government agencies (especially between the DoE and the DoT, and MTNL and VSNL); and because companies have been slow to give commitments, there have been delays in the introduction of many infrastructural facilities. For example, the software technology parks were announced in the 1986 policy but were not functioning until late 1990.

However, substantial progress has been made in the late 1980s, particularly in international telecommunications; an area previously characterised by a very slow pace of change. Not only has the government reduced charges and invested more money in infrastructure, but it has also created a series of committees and agencies which have been more representative of, and responsive to the software industry. These bodies have set up facilities specifically targetted at this industry's needs.

The example of Texas Instruments indicates that multinationals can fund infrastructural development, but this is an unusual example which still relies largely on publicly-provided links and which presents a route not open to the vast majority of Indian software companies. Private companies cannot afford the very high investments required to create a telecommunications infrastructure and they have necessarily relied on government, which can take advantage of scale economies to provide access to a wide range of industrial users.

As a result of the government's actions, both availability and use of infrastructural facilities have increased - dramatically so in the case of telecommunications if one compares late 1988 to late 1990. This has helped to improve India's credibility as a software source which, in turn, has increased overall growth prospects and the level of offshore working. Indeed, provision of telecommunications links has been a necessary part of the great majority of Indian companies' offshore work.

A whole range of other infrastructure has been provided by government though this, too, has been aimed substantially at exports. Domestic-oriented production has benefited from infrastructural interventions during the 1980s but not to the same extent as export production.

6. Marketing and market information

Government bodies have been assisting software export marketing since at least 1974, when the Electronics Trade and Technology Development Corporation was including software in its counter-trade negotiations with representatives from the USSR (GoI 1975a:5). Then, in 1981, the Engineering Export Promotion Council (EEPC) constituted a software panel and began to include software companies on overseas trade visits (Raman 1985).

It was soon felt that the EEPC's remit was too wide to do justice to the special thrust given to electronics-related products and that a specialist body was required. Therefore, in 1985, a decision was made to set up the Electronics and Computer Software Export Promotion Council (ESC) (Computers Today 1985c). By the time this council became active in 1988, two other bodies - the Trade Development Authority (TDA) and the Software Development Agency (SDA) were also helping to promote software exports.

In 1988, these three organisations - ESC, TDA and SDA - were tending to duplicate each other's efforts as they attempted to take some of the reflected glory from this rapidly growing export. However, by 1989, the roles were more clearly demarcated with the ESC as the central export promotion body, working closely with the more policy-oriented SDA[29]. Other bodies (including the TDA, the State Trading Corporation, the Trade Fair Authority of India, and the Federation of Indian Export Organisations) supplemented where they could.

With regard to marketing, these government organisations cannot create buyer-seller relationships, so their role has been to raise general awareness and to create the environment in which such relationships may begin. This has been done by organising subsidised trade exhibitions and meetings in foreign countries, and by coordinating visits of foreign buyers or government bodies to India. Though sporadic in the early 1980s, the overseas exhibitions became annual events in the US, Australia and Europe after 1986.

At the CeBIT '89 trade fair in Hanover, for example, nearly US$1m was invested by government to allow a subsidised stall rate, without which many companies could not have afforded to attend (Computers Today 1989). The government agency also undertook all the bookings, stand construction, publicity and other arrangements in Germany, transported the companies' panels and literature, and got fast clearance for a release of foreign exchange[30]. Of the 70 organisations that attended, 29 were software companies, including some which were new to exports and which used the opportunity to pick up marketing skills through discussion with, and observation of, government officials and more well-established exporters.

The government's aim in funding and organising these overseas visits is to raise awareness and to address general images of India and the credibility of India as a software source (Dataquest 1989b). In this, the visits seem to have been largely successful, presenting an able, efficient, 'high-tech' image of India and of the Indian bureaucrats, who use the

[29] At that time the ESC, which is overseen by a joint industry-government committee, had over 150 software companies among its total membership of 450 (Interviews, Mathew 1989b).

[30] Similar arrangements were made for other exhibitions (GoI 1987b). These are often wholly organised by a government agency and solely concerned with selling Indian software.

opportunity to constantly emphasise their willingness and their desire to encourage trade and collaborations.

The exhibitions have also acted as a show-case and source of feedback for Indian software packages, though some of the other constraints noted in chapter 4 have meant that this has not been sufficient to significantly increase Indian software package exports.

What the visits cannot do is alter individual company credibility - they provide the contacts but it is up to the firm to turn these into contracts. Because this latter process can be costly and difficult, and in response to complaints that exhibitions were not adequately geared to selling software services, in the late 1980s the government agencies turned more towards organising smaller seminars and workshops (rather than attendance at exhibitions) which made it easier for sellers and potential buyers to come together and talk to one another.

Not every overseas show has been a success in terms of interest generated but these government marketing activities have been praised by both companies and independent commentators as helping larger companies to diversify their collaborations and helping smaller companies to find clients (Interviews, Computers Today 1989b, Dataquest 1989b, Nasscom 1990b).

All three of the principal export promotion agencies, plus the ExIm Bank, have assisted in the process of providing market information to Indian software companies. They have conducted analyses of foreign software markets and reported other market research work, either in monthly newsletters or as separate reports. The ESC newsletter also provides details of software tenders, of foreign companies looking for tie-ups, of forthcoming trade fairs and of software policy changes[31]. The agencies were not so useful in providing information of use to software package producers but there were suggestions in the late 1980s that the new National Software Centre might do this (Elsoftex 1989b).

6.1. Summary and conclusions

The entry barriers into export markets are a major obstacle to software industry growth (UNIDO Secretariat 1983:22-23, Fialkowski 1990). The main strength and purpose of foreign collaborations from an Indian perspective has been their provision of access to these markets by reducing financial and information barriers.

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[31] In addition, the ESC compiles trade statistics; offers advice and a step-by-step compendium on dealing with various bureaucratic procedures; and acts as an effective intermediary between government and industry on matters of policy formation and implementation.

However, the collaborations have also brought costs. As a result, larger Indian companies want to diversify away from dependence on a main collaborator while smaller companies, which cannot access long-term relationships, want to escape from the high commissions and relative growth uncertainty associated with contracting agencies. Nor have collaborations addressed the general issue of awareness of India as a software source.

The government has been the only obvious body to co-ordinate the kind of large and general marketing operations with economies of scale that individual companies could not afford. Although there has been rivalry between the various government marketing agencies, this and specific software industry needs have been responded to. Government agencies have provided assistance by organising and financing marketing visits, and by undertaking market research and reporting market information.

This has helped some companies build marketing skills and has been the necessary precursor for a significant number of software services export contracts. Without it, many software companies, particularly smaller ones, would have had much greater difficulties exporting.

The government's efforts have seen less success as regards software package exports. Dozens of software packages have been demonstrated but, by itself, this is not enough to overcome the substantial barriers to package exports and the government has not been willing to take responsibility for the very high costs and risks associated with successful promotion of individual products.

7. Procurement policies

Clearly, government procurements cannot directly affect the market for Indian software exports but they have been addressed to the domestic software market. This has been particularly important because of the constrained size of the domestic market and the fact that Indian government software spending makes up more than 50% of the total market (Interviews)[32].

7.1. Software products

Government policies have helped to increase the overall size of the domestic market for software products through heavy demand for hardware; the introduction of copyright

[32] Compared to 4% in the UK and 15-20% in the US in the mid-1980s (Coopers & Lybrand/IDC 1986).

legislation; and the subsequent instruction that there should be a separate software component within all information systems tenders from public sector bodies. Such rulings, though, do not necessarily affect the market size for indigenous goods and, like many Indian consumers, government departments have often shown a preference for foreign packages rather than locally-produced ones (Computers Today 1986e, Nigam 1987, Ghosh 1988b)[33]. There were some signs of change in the late 1980s and, by 1989, the public sector was the major client of domestic product developers like Softek (Interviews).

7.2. Software services

Government purchases of indigenous software services have far exceeded those of local software products. A major example of the positive role such purchases can play is seen in the 1984 decision to let the local company, CMC, develop software for the computerisation of the Indian Railways' reservation system rather than buy or adapt foreign software. In financial terms, this not only increased the market for local services and brought revenue to an Indian company but it also saved substantially on foreign exchange.

A greater gain arguably came from CMC's use of the project to build a large team of skilled and experienced workers. Several dozen programmers learned their coding skills from this contract and it gave CMC their first experience of managing a very large software project (the largest in the country at the time). The government has therefore not only addressed formal education (see above) but also the equally important skills source of on-the-job training (Bhatnagar 1986, Schware 1989:61).

This work also enhanced the company's ability to tender for other contracts in-house, in-country and overseas. This happened because a base of skills was built up which could then be applied to other contracts and because this project was a huge demonstration of CMC's abilities which could be shown to clients. Subsequent contracts won with the help of the reservation contract include work on computerising the Indian Railways' freight system; the computerisation of the large Nhava Seva port complex in Bombay (Dataquest 1989h); work worth several hundred thousand pounds with the London Underground and Felixstowe port in the UK (Dataquest 1989c, Computing 1990a); and the computerisation of rail reservations in China and Egypt (Dataquest 1990w).

33 Unlike the Brazilian government, which has had a policy of preference for domestic sourcing of software (Correa 1985:51).

By building up the standard of domestic market work, the government has also contributed to persuading more software developers to work on domestic projects, and so slightly alleviated the severity of the 'brain drain' and the lack of skills transfer between export and domestic market work.

A complaint about government and public sector contracts has been that too many of them were awarded to the government's own National Informatics Centre or to CMC, which is public sector (Interviews). Those contracts that private companies did receive were often poorly paid and just for 'low-level programming'. There may be good reasons for this in that both NIC and CMC have become large and experienced software development organisations, but the effect has been to restrict the spread of skills and benefits that government contracts can offer (Mehta 1988). There were some limited signs of change in the late 1980s, with all government contracts being put out to tender rather than awarded directly.

A different, but equally important example is that of the Rangarajan committee's recommendations on bank automation (see chapter 6). The uniformity this imposed across thousands of potential computer sites created a large, homogeneous market and provided a focus for the development of skills in both banking and Unix software by Indian firms (Khanna 1988b). As already mentioned, this has had a fortunate spin-off in export markets because of the rapid growth in the global Unix market in the late 1980s.

Finally, the type of applications has also been important with government-funded contracts being the only ones attempting to channel information technology resources towards some of India's basic needs, such as rural and agricultural development.

7.3. Summary and conclusions

Through its demand-related policies, the government has had the ability to address many of the constraints affecting the Indian domestic software market in a way that multinationals and even the Indian private sector have not. Although the domestic market remains relatively small, government procurements and tendering recommendations (and copyright legislation) have certainly raised the overall level of local demand for software very significantly and without them the domestic market would have been far smaller. These interventions have also helped to save some foreign exchange.

Although a substantial part of demand was directed at foreign software packages and at software services sourced from the public sector, government and public sector purchases were increasingly forming a significant part of many domestic-oriented companies' revenues in the late 1980s as government responded to earlier criticisms.

Software services contracts have been of much greater influence than product purchases. They have assisted revenue growth; led to a build-up of skills, including those of analysis and project management which were in shortest supply and which few training courses addressed; and provided a 'track record' of credibility and demonstrable achievement[34]. These skills and credibility have, in turn, been able to feed positively into exports.

Over and above this, the government's actions have helped a little to reduce the imbalance between export and domestic markets by addressing a wide range of domestic needs and by providing stimulating domestic-oriented work which attracts talented software developers. This can help to reduce the loss of skilled staff overseas and to stimulate skills transfers, neither of which have been achieved by export orientation or foreign collaborations.

8. CMC

In 1976, the Indian government set up the Computer Maintenance Corporation to provide a range of computer support services to Indian computer users and to break the monopoly of the multinationals on computer maintenance[35]. By 1989/90, CMC Ltd (its name was changed in 1984) was the only public sector company with a significant presence in the Indian software industry, though it also still provided a large range of other IT services, including hardware maintenance and training. In 1989/90, CMC was India's second largest IT company with a turnover of approximately US$75m and a workforce of more than 2000. Its growth since 1976 had been financed entirely from public funds and profits.

Instead of focusing on software development for export, CMC has oriented the major part of its efforts to domestic market work. Most of its development work has been centred on applications outside the normal business arena, such as rail freight and passenger transport control, water pollution and irrigation management, hospital management, mine environment monitoring, and power utility management. It has also developed software packages covering a wide range of applications in telecommunications, Indian language processing and rural development.

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[34] A similar process has been seen in the US and European countries where 'the opportunities to work on contracts to meet ... national needs have been of indispensable value in the growth and maturation of the software industry.' (Narasimhan 1984:47-49).

[35] This and all other information in this section comes from interviews, CMC (1988), Mukhi & Chellam (1988), CMC (1989) and Dataquest (1990w).

As noted in the previous section, the skills and credibility that this work has built up have then enabled CMC to bid successfully for turnkey export contracts as well as for further domestic work from both private and public sectors. The skills developed range right up to large project management experience and, thanks to the low level of export work undertaken and to the wide range of stimulating domestic work available, CMC has not suffered as bad a loss of staff as some of the larger export-oriented firms. In 1990, CMC had no active foreign collaborations but had been given permission to buy the UK software company Unisoft to assist its entry into Western markets.

This company has been able to undertake research and development in a wide range of software technologies, and it has developed and marketed its own database management system and graphics packages, as well as more state-of-the-art artificial intelligence and natural language processing applications; all of which compete with and substitute for imported packages. Like NCST, CMC has been able to transfer some of its capabilities to other organisations by running a series of training courses covering both basic and specialist software skills. In 1989/90 more than 10,000 students were trained in this way.[36]

The fact that CMC is a government of India enterprise is of interest since it indicates that public sector companies can be successful in the software industry. Indeed, much of its success must be put down to its close relationship to government - something resented by private sector companies.

However, of greater interest is the fact that CMC, through government guidance, has presented an alternative model to that offered by most of the Indian software industry. Instead of orienting itself towards exports and foreign collaborations, CMC has remained firmly rooted in the domestic market, using most of its workforce to address Indian development needs instead of the needs of foreign firms and countries.

Only when they form a natural extension of its domestic work has the company chosen to look for export contracts. It has done so using its own marketing resources and only where turnkey (rather than just programming) contracts were on offer. As a result, CMC has remained independent of foreign influence and has been able to rely on its own large base of technological capabilities, which is sufficiently strong to have addressed software package import substitution.

[36] CMC also conducts a nationally-recognised computing examination.

It is impossible to tell what the Indian software industry would have looked like if the whole industry had consisted of companies following a CMC-like path. What the history of this company does indicate is that at least some software industry development can be achieved through government intervention and without the overemphasis on services exports, package imports and foreign collaborations that has characterised the rest of the industry[37].

9. Conclusions

> "Recent historical evidence provides little support for the view that market forces alone can be left to determine the size, composition and characteristics of a country's industrial sector. It can be argued that governments in at least the majority of developing countries ought to retain some responsibilities for the process of industrialisation." (Weiss 1988:284)

This sentiment is echoed by the findings of this chapter, in which it has been seen that the Indian government has intervened widely to influence the development of the Indian software industry. Its measures have at times been delayed in their implementation and characterised by inter-agency bickering, and there is obviously room for improvement. Nevertheless, the government has also shown itself to be iterative in its approach, responding to the shortcomings of previous interventions and to the changing needs of the software industry[38].

Many of the interventions described here have been introduced since the thrust to software industry growth in 1986. As a result, an evaluation at the time of writing must be tentative. Nevertheless, it can be seen that the Indian government has addressed itself to the fundamental problems affecting this industry's development. These problems have led to slower growth than might otherwise be achieved; to a persistent international division of labour; to a bias towards larger firms; and to an emphasis on software services rather than products, and on exports rather than domestic-oriented production. In addressing these, the government has also adopted an industry-specific approach, increasingly gearing its responses to the particular needs of software development rather than those of Indian industry or the Indian IT industry as a whole.

One interesting aspect of the interventions is that many of them have centred around a series of organisations, including ExIm Bank, ICICI, VSNL, NCST, ESC, the software

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37 Martinussen (1988:186) also notes the Indian government's use of the public sector as an alternative to dependence on multinationals.

38 Also noted by Dataquest (1988i), ESC (1988:7), Raju (1988), Kohli (1989a) and Schware (1989:39).

technology parks administrations and CMC. These have been created or are owned by government but they have been partly autonomous from government and more responsive to industrial needs, with some of them being governed by a joint industry-government board. Even the Department of Electronics itself has been more technocratic than bureaucratic and has had a relatively positive relationship with Indian industry. The existence of such organisations which differ from the longer-established, more bureaucratic structures within the Indian government may be an important element in the success of interventions.

Although, by 1990, the impact of the interventions was limited in its overall effect on the Indian software industry, it could be seen that the government's actions had helped to improve software-related financing, skills, infrastructure, marketing and domestic market size. These actions were helping to overcome the constraints to supply inputs and other market barriers that affect this industry, and to increase the skill-, capital-, technology-, and marketing-intensity of Indian software production.

Marketing interventions have been aimed entirely at exports; those relating to finance, skills and infrastructure have been distributed more to export than domestic work because of the pre-existing bias to exports; and R&D funding and government procurement have directly assisted the development of domestic-oriented production. Thus, although there has been an export bias overall within these interventions, without them there would have been a far worse imbalance and even less integration between export- and domestic-oriented production. In the absence of state intervention there would also have been a greater imbalance between onsite and offshore export development, and a lower level of overall industrial growth.

There has been less success in addressing the constraints on package development and small firm growth, with most financial and procurement measures tending to favour software services and larger firms, and with marketing also having supported the export of services more successfully than that of packages. Nevertheless, there were signs at the end of the 1980s, particularly through the increase in venture capital funding and the inclusion of small firms in overseas delegations, that some benefits were trickling through.

The benefits of government intervention have been recognised not only in India and other developing countries, but also in developed nations, where,

> "To a significant extent the United States, Japanese and French governments have strengthened their software industries by a variety of measures" (Schware 1989:78)

These governments have intervened in the provision of finance, education and training, R&D funding and government procurement, all of which have assisted software industry development.[39]

In chapter 1, the neo-liberal model was shown to argue that the state should not intervene in demand for final products or the supply of inputs, because these will develop 'naturally' as the industry develops (Colclough 1989:4, Foley 1989:14). The conclusion to be reached from this and preceding chapters is that what has developed is a series of demand and supply constraints, and that government intervention has played a positive and necessary role in trying to overcome these constraints and in the overall development of the Indian software industry[40]. This therefore lends support to the structuralist rather than the neo-liberal model.

The neo-liberal model is further discredited because of its uni-dimensional view of state policy as only economic, and its requirement that the state's economic role should be minimised. Here, the state has been shown to be a multi-dimensional actor that intervenes with economic instruments, but which also intervenes in financial provision and planning, skill formation, infrastructure construction, the planning of R&D, as well as in direct software procurement and production.

This also makes it clear that, as with 'liberalisation', one cannot talk in uniform terms about 'intervention' because interventions can take many different forms, from those described here, to the import protection and industrial controls described in previous chapters.

Within the context of this study, it is impossible to say whether the development of the Indian software industry would have been 'better' had the government guided the industry to rely on interventions rather than foreign collaborations. What has been shown is that the state interventions described provide viable alternatives or complements to sole reliance on collaborations, and alternatives that are often associated with fewer costs than were detailed in chapter 7.

By comparison with collaborations, the government's actions have been associated with a greater flow of finance and skills to the domestic market, and with a much greater emphasis on domestic-oriented production and the use of Indian labour to address Indian economic needs. The government has provided a model for exports as a natural extension of domestic market work, rather than as the 'hothoused', isolated activity it is in many Indian

[39] As pointed out in chapter 1, the NICs, too, have intervened heavily as part of their industrial strategy.
[40] A sentiment echoed by Mahalingam (1989).

software firms. There has also been greater independence for the software companies (and less vulnerability) and some signs of a reduced 'brain drain'. All of these alternatives have been amalgamated into a single example in the form of the public sector firm, CMC.

There has been some suggestion of a 'division of labour' in the provision of inputs, with the private sector and multinationals specialising in certain inputs and the government in others; for example, in the type of skills provided. Certainly the government seems to have acted most positively where it has been able to take advantage of scale economies to provide general marketing assistance, infrastructure and a large range of general skills which industry can then 'top up' with more specific needs. However, it has also intervened to counteract some of the negative aspects of multinational involvement, so that the roles of government and multinationals cannot be seen as completely complementary. (Nevertheless, nor is it true to say that they are mutually exclusive.)

It is clear that both liberalisation and increased government intervention have co-existed in the development of the Indian software industry, and that it is incorrect to view them as mutually exclusive alternatives.

> "A conflict is often posed between greater controls and greater liberalisation. This can sometimes be a false conflict diverting attention from a larger set of issues. Both controls and liberalisation must be seen in a longer term planning perspective. This is specially important in the case of technology development." (Mody 1983)[41]

Similarly, intervention has been seen as an integral part of the export-oriented strategy adopted for software by the Indian government, with the growth in exports requiring a growth in government interventions on skills and infrastructure and, to a lesser extent, finance and marketing. This further undermines the simple association of continua suggested in chapter 1 since state interventions have now been seen to be part of both export-oriented and pro-foreign investment strategies.

[41] Hussain (1987:369) also argues for a mix of market liberalism and state intervention.

CHAPTER 9

MAKING AND CHANGING POLICY

Introduction

Thus far, there has been relatively little explanation of why software policy is the way it is, and why it was liberalised. Given the description of software policy in chapter 2, one might imagine policy measures being decided by a group of bureaucrats relying on objective economic criteria to help steer the industry towards rationally-chosen development goals.

Subsequent details, however, have suggested that a simple, objective model of policy making does not hold good. These have indicated that technical and economic factors have constrained available policy choices, and that political factors - the influence of the Indian Prime Minister and of foreign governments and companies; lobbying by Indian producers and consumers; and power struggles between government bodies - have also helped to determine the outcomes of policy making.

This chapter seeks to understand the process of policy making in India and the factors that determine and constrain the direction of government policy and the nature of changes to that policy. Why, for example, did Indian software policy, like that of other industries, show three relatively distinct phases between 1984 and 1990, associated with a progressive slowing of liberalisation? The answer would seem to lie in the changing balance of political power between interest group coalitions during this time.

In this chapter, it is the intention to seek to understand policy making not just for the sake of understanding but also in order to evaluate the relevance of policy recommendations, particularly of relatively all-embracing models such as those presented in chapter 1. It will be argued that a fuller understanding of the policy-making process highlights technical, economic and, especially, political constraints within the making of Indian software policy.

The constraints described, which are assumed to exist within other policy spheres, make it inconceivable that any sweeping, all-embracing model could be universally applied to all the different countries and industries in the world, or even to different industries in the same country. Any policy recommendations must include an understanding of the specific technical and economic factors that affect an industry; of the state of that industry's development; and of the power relationships within the industry, government and between the two.

It will also be argued that the application of any fundamental change in policy direction is unlikely to be achieved under normal circumstances because of the need for compromise between various interest groups; and that policy strategies involving growth of exports or foreign collaborations bring an increasing necessity to compromise between indigenous policy objectives and foreign influence.

1. Non-political factors affecting software policy

Although the main focus of this chapter will be on the various interest groups which influence policy making, it will be helpful to review some of the other factors which have helped to determine the nature of Indian software policy measures.

In chapter 5, it was seen that the nature of software technology has constrained available import policies[1]. The government intended to boost local software production by simultaneously liberalising the import of software tools and protecting the local industry against imports of software packages. This had to be abandoned when it proved both technically and bureaucratically impossible to differentiate between software tools and software packages.[2]

More importantly, the whole direction of changes to software import policy was constrained by the rapid growth of consumption of microcomputer software in the mid-1980s. The particular nature of this technology made it highly susceptible to both piracy and smuggling, which would have allowed circumvention of any protectionist policies. This strongly encouraged the government to liberalise and delicense software imports[3].

In the same chapter, it was also noted that economic resources have played a role in constraining policy choices. In particular, Indian government policy has tended to swing back and forth between relative import liberalism and protectionism depending on the state of the nation's foreign exchange reserves, with a shortage tending to precipitate a slowing

[1] In chapter 6, it was also seen that the nature of hardware technology strongly determines whether or not it can be imported or manufactured locally. The intimate link between hardware and software technologies also helped to delay the emergence of a separate software policy.

[2] Rules on the proportion of imported-computer time to be used on exports were also dropped in 1986 when it became clear that it was neither technically nor bureaucratically feasible to enforce them.

[3] In the same way, the inability to control software import through international telecommunications links has led the government to make this an open process.

or reversal of any previous liberalisations[4]. The overall level of revenue availability also constrains what can be done. No government has unlimited resources and this sets limits, for example, on the extent of education provision (as seen in chapter 7).

Finally, a point made in chapter 6 was that choice of policy will be constrained by the stage or state of industrial development and technological capability. India in the 1960s had no information technology industry or capabilities, and so had little choice but to allow relatively liberal imports and to rely on foreign multinationals. Similarly, a private *sector industry will be less-readily controlled* and will require different policy measures to an industry dominated by public sector firms.

Summary and conclusions

A summary of findings from previous chapters indicates that industrial policies cannot be adequately constructed solely from the perspective of economic criteria. Policy choices have been constrained and partly determined by the nature of the technology and bureaucracy involved; the availability of foreign exchange and government revenue; and the state of industrial development, capabilities and ownership. This means that not only individual nations but also individual industrial sectors within those nations are likely to need specific policies[5].

2. Political pressures affecting software policy

In order to understand the political factors that affect the policy-making process, one must look at the main interest groups involved. That the state, mainly in the form of bureaucrats, should be involved in policy making, is obvious. Similarly, industry has always taken a great interest and an active involvement in policy making.

> "Most questions of public policy are of deep and direct interest to leaders of business and industry. To lobby intensely with politicians and bureaucrats, particularly for shaping the contours of economic policy, is a normal part of the activities of the business community" (Minhas 1988)

Thirdly, as *noted in previous chapters*, there are 'external' pressures from foreign governments and foreign companies.

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[4] EPW (1986), GoI (1987e), Poe (1987) and Lucas (1988) also note the connection between foreign exchange availability and import policy in the Indian context. Weiss (1988:307) does so in general terms.

[5] Wiemann (1987), Lucas (1988), Kaplinsky (1989) and Bagchi (1990) all support the idea of sector-specific policies.

Each of these three groups will be analysed in turn, focusing on their specific interests, particularly vis-a-vis liberalisation; on the inputs they have made to the software policy-making process since 1984[6]; and on the way in which these inputs have or have not been translated into concrete policy measures. A chronology of the changing power and interests of these groups will be used to help explain the way in which software policy changed between 1984 and 1990.[7]

2.1. Interests and influences of groups within Indian industry

> "The elements which make up the [Indian] private sector ... are extremely heterogeneous and consist of traders, small-scale manufacturers, and large-scale indigenous and foreign manufacturers" (Kochanek 1989)

The software industry is no exception and its 'mainstream' can be divided into two groups.

i. A large number of small and medium-sized software companies (most of which do domestic work as well as exports) which want cheap access to imported inputs that they can use in their work. There is a strong entrepreneurial streak running through these companies. They feel, as one senior manager put it, 'The best thing a policy can do is to get the hell out of the way' (Pratap & Mathai 1988).[8]

ii. A few very large software companies which undertake a diverse range of operations including exports, trading, and sales of their own products domestically. Because of this, they have interests in a variety of different policy measures.[9]

There are two further, smaller groups.

iii. Domestic-oriented companies, which sell the software packages they have developed within the Indian market and which want to remain protected from the competition that liberalised imports bring.

iv. Trading companies and would-be traders like the hardware companies, which do not make software themselves; they only resell other companies' products. They favour liberalisation which will allow them to trade in imported and other software.

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[6] The post-1984 period only is addressed because this was the time during which software was recognised as, and became, a significant industry, and during which the most significant policy liberalisations took place.

[7] The policy-making process is not very widely discussed or written about. As a result, many of the details about the making of software policy have been obtained from interviews alone.

[8] Hussain (1987) describes the presence of such a group within Indian industry as a whole.

[9] Kohli (1989a) describes the presence of such a group within Indian industry as a whole.

There is also a fifth group - those companies which are subsidiaries of foreign multinationals - which will be discussed below.

Because of this heterogeneity of interests within the industry, there has been no simple, industry-wide response to policy issues, particularly those of liberalisation or protection of new technology imports. Companies within each category have favoured certain policy liberalisations but not others.

For example, domestic-oriented companies wanted a liberalisation of imports of software tools but wanted protection against imports of software application packages. Similarly, the large companies were in favour of liberalising the regulations governing spending of foreign exchange but were against liberalising policy so that all software export companies could do whatever they wanted with their imported hardware.

Different policy measures created different coalitions of interest between firms in the various categories. In 1986, for example, while domestic-oriented companies were calling for increased software import protectionism, the other groups united to oppose them and to support lower import duties (Dataquest 1987a)[10]. In early 1987, on the other hand, the very large companies and the domestic-oriented companies both supported limitations to the 'stock and sale' rule on software distributorships while the traders and small and medium companies opposed such limitations (Raju 1987, Computers Today 1988c)[11].

Very large software companies and policy

While all software companies have had some influence on policy making, their influences are by no means equal and there is one group - the very large companies - which had a much greater influence than the others and which has often benefited more than others from policy changes[12].

In some cases, the benefits have probably been fortuitous. For example, it seems unlikely that the largest companies lobbied for higher export obligations on imported hardware, because these eat into their foreign exchange permits. However, when the export obligations were raised in 1986, larger companies, having much larger export revenues, were able to cope more easily than smaller firms (Dataquest 1987a).

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10 Further described in Computers Today (1986c), Hebalkar (1987) and Nigam (1987).
11 Further described in Hebalkar (1987), Menon (1987) and Nigam (1987).
12 The latter point is also made by Harriss (1989).

In other cases the largest companies have deliberately lobbied for policy changes that would protect or enhance their own position[13]. One of the reasons is that industrial entry and production capacity licenses have not been required in the software industry since 1984. In many of the more traditional Indian industries, established companies use such licences to help block out competition, but the very large software companies have had to look to other measures.

Two examples were given in chapter 2. The 1987 '10 crore rule' effectively allowed the largest companies to lease out their imported computers and to pay off their export obligations in whatever manner they chose, while restricting smaller companies to exports that made use of the imported computer which had attracted the obligation in the first place. This offered the largest firms a legitimate, profitable benefit that is allowed to no other company. Similarly, the 1987 changes to 'stock and sale' rules on distribution of foreign software effectively restricted distribution rights to large software exporters, thus removing potential competition from trading and hardware companies (Menon 1987, Computers Today 1988c). In both cases, the largest companies explicitly lobbied the government to introduce these changes.[14]

Influence of very large companies on policy making

Why are large companies better able than other groups to influence policy to get what they want? The two largest companies have staffs of between ten and twelve people dealing with government and policy matters, of whom five or six deal directly with government officials in Delhi. Each company has a key figure in Delhi who knows all the relevant policy makers, and to this person is added the influence of top managers who come to Delhi to lobby for policy changes. These managers interact with officials at all levels from the Cabinet Secretariat downwards.

Kochanek (1989) describes the Delhi office as the business house's 'industrial embassy', which 'employs the highly personal system of liaison and lobbying developed after independence as an attempt to influence the political elite largely for individual benefit, although some collective benefits might incidentally accrue'[15]. The main lobbyist for one of the largest companies emphasised this point - his interactions with government aimed

[13] This has been seen more in relation to the domestic market, where demand is limited, than in exports.

[14] Larger firms have benefited through policy more than small firms from better access to indirect finance through all policy elements that link allowances to previous export earnings, and from better access to direct finance. Larger firms have also benefited from their greater experience and credibility; greater ability to attract better workers; and greater ability to tie up with multinationals and thereby access skills, technology and export markets.

[15] This is also described by Minhas (1988).

'To see that future plans do help the industry greatly but that they help my company the most'.

Behind the two largest companies, other companies have a decreasing ability to influence policy. The nine or so next biggest firms have a Delhi office, with perhaps one or two staff, part of whose function is to put forward the company's viewpoint on policy. These companies do have some policy input, and about ten of the largest software companies were invited to the series of Development Council for Electronics Industry meetings held in 1985 and 1986 to discuss the formation of software policy (EI&P 1985c, EI&P 1986b).

By contrast, all the smaller companies were left out of this process. Some of these firms have chief executives who go to meet bureaucrats but most have had to rely mainly on trade associations for their approaches to government.

As well as the two generalist trade associations, Assocham (Association of Chambers of Commerce) and FICCI (Federation of Indian Chambers of Commerce and Industry), the two associations relating specifically to software are the software sub-committee of MAIT (Manufacturers' Association of Information Technology) and Nasscom (National Association of Software and Service Companies). While such associations appear more democratic than the 'free market' of direct lobbying, being 'designed primarily to achieve collective rather than intermittent action', the larger companies have a major say in these associations as well (Kochanek 1989).

The governing committees of MAIT and Nasscom are mainly made up of representatives of the largest software companies, giving these firms a 'double-barrelled' approach to government. They use the associations to put forward core policy requests, such as liberalisation of software imports and foreign exchange permits, topped up with individual access to lobby for individual benefits, such as restriction of stock and sale permission or the 10 crore rule[16].

Another reason large companies are favoured in policy making is the power of money. Secondary sources are fairly explicit about this.

> "Besides gathering information from the bureaucrats and politicians, these government relations out-fits of the companies spend fair amounts of money to manipulate particular policies of government to ensure tranquil and profitable operations for their parent firms." (Minhas 1988)[17]

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16 This process is also described by Kochanek (1989).

17 Nehru (1982) also discusses the influence of payments to Indian government officials.

During data gathering for this research, no direct evidence was brought forward about corrupt payments for manipulation of software policy but Delhi-based lobbyists of software firms would certainly admit that money was spent on 'entertainment' of bureaucrats (taking them out for meals, lending them a car for a particular journey) and on bringing chief executives to Delhi to meet the bureaucrats. Even laying aside the corruption argument, in this degree those with more money are liable to be more successful in their lobbying than those smaller firms with less.

One final reason for the greater influence of the larger firms is that bureaucrats seem to prefer talking to representatives of the larger, older-established companies, which they know can earn significant amounts for the country. For example, Dr Seshagiri, Additional Secretary at the Department of Electronics, announced in May 1986 that his subsequent policy discussions would be with 'certain major organisations like CMC, TCS, TBL [*the three largest software companies*] and five, six others', which were 'the successful ones, the winners, to understand how they won' (EI&P 1986b)[18].

Very large companies and liberalisation

Building up a picture of the type of policies that the largest software companies want, it would appear that they have not favoured all liberalisations of policy. They want to expand their own operations but at the same time, if possible, protect their dominant position within the industry.

They have therefore pushed for liberalisation of access to software production inputs such as software tools, hardware and the foreign exchange required for marketing. However, quite often they want this access to be restricted, either to software exporters or, as in the case of the 10 crore rule, only to large software exporters. As regards their trading and distribution operations, they also oppose a free market and want to maintain the system of restricted entry that the present stock and sale policy confers. As domestic producers, they have been in favour of some software import duties. Therefore, in the context of the software industry in the 1980s, it would appear that the largest companies have generally favoured a liberalisation of policy but not a complete liberalisation.

In some ways, the largest companies can be seen as a microcosm of the whole industry. Their operations are diversified, so that they are exporter, importer, trader and domestic-oriented company all rolled into one. Given this, it is not surprising that they are not committed to complete liberalisation since certain elements of their 'personality' would oppose liberalisation. Based on the interests of the largest companies, which are the

[18] This is also described in EI&P (1987).

most influential industry group, one would expect policies of the type present in 1984 to end up partially liberalised and that, the further liberalisation progressed, the more likely these companies would be to find themselves not supporting additional liberalisations.

Summary

The Indian software industry cannot be seen as a homogeneous lobbying bloc because it consists of five different groups - very large companies; small and medium entrepreneurs; domestic-oriented companies; traders; and multinational subsidiaries. Each of these has different policy interests and they all form different interest group coalitions around all proposed changes to software-related policy[19].

Except for the multinational subsidiaries, it is the largest companies which have benefited most from most policy changes. They have had the strongest industrial influence on policy because of their greater access to lobbying staff and finance, and to trade association channels. They are also favoured by bureaucrats because of their large earning potential, and they have used all this to try to maintain a dominant position in the industry.

As a result, they have supported only limited liberalisation of the 1984 policy position. They sought some liberalisation but also some protection and restrictions so that, as software policy liberalisations and proposed liberalisations spread between 1984 and 1987, their support for a continuation of this process diminished.

By comparison, medium-large companies have had some policy influence while the smallest companies, of which there are several hundred, have had very little.

2.2. Interests and influences of groups within the Indian state

Described above were some of the ways in which software companies are able to influence the bureaucrats of the state and in which the state appears sympathetic and supportive of industry. However, other interests are discernible within the bureaucracy, some of which are not necessarily in sympathy with the interests of industrial groups. For example, bureaucrats within the Ministry of Finance (MoF) can demonstrate a good deal of autonomy from industry, while others are openly suspicious of industry and seem to regard policy

[19] They have all tended to be reactive and concerned with policy measures rather than proactive and concerned with policy objectives.

making and implementation as a game of wits between state and industry. Thus, like industry, the state itself is not homogeneous but consists of different interest groups, as described in the following sections.

Pro-liberalisation

Rubin (1985) feels one of the main contributory factors leading to the recent round of liberalisation was that some of those in positions of power within the state held a neo-liberal viewpoint and believed that the lack of liberalised policy measures was a major cause of slow industrial growth in India.

Within the formation of software policy, one of the dominant features is that a single person - Dr Seshagiri, the DoE Additional Secretary - played such an important role. He is generally credited with being 'the architect' and 'the moving spirit' behind the 1984 and 1986 policies (Malhotra 1987) and he argued in favour of liberalisation not because any interest group wanted it, but because it was his personal conviction.

Seshagiri's views can be seen from his statements about the principles underlying policy.

> "One of the principles is what is called the 'natural propensity' and the 'natural intrinsic economic advantage' of a country ... These are evolutionary features. Anything that you do, has to finally contend with and come into equilibrium with these intrinsic factors ... We want to take this industry headlong into international competition. How can you do that with the kind of protectionism that we have been having all these years?" (quoted in Malhotra 1987)

Seshagiri's convictions formed one of the strongest pro-liberalisation factors within software policy making, and none of the other bureaucrats involved has spoken up whole-heartedly in favour of liberalisation as Seshagiri did.

Rajiv Gandhi, when he was Prime Minister, took a personal interest in the liberalisation of software policy and Seshagiri was fortunate in receiving support from Rajiv, and from a number of other ministers and advisers who also supported policy liberalisation (Kohli 1989a)[20]. That support had an important impact, with one interviewee stating, 'But for the fact that the PM was in sympathy, Seshagiri would have been sacked long before'.

20 Including V.P. Singh, who was Finance Minister during the early part of Rajiv Gandhi's term in office.

Protecting local industry

Policy objectives have not been uniform within the Department of Electronics. DoE Secretaries are frequently drawn from the local electronics industry and are often in favour of building up and protecting that industry. S.R. Vijayakar, the DoE Secretary from 1984 until 1986, came to the job from the large public sector hardware manufacturer, ECIL, though he is said to have 'played a passive role' and left software policy making to Dr Seshagiri (Dataquest 1988b). His successor, K.P.P. Nambiar, had previously been head of Keltron, the Kerala State Electronics Development Corporation, and his sympathies for protecting local firms were noted by a number of interviewees.

A desire to help local industry does not necessarily mean a rejection of all types of liberalisation. Nambiar, for example, wished 'to minimise physical controls and use fiscal measures' (Pratap & Mathai 1988). However, while Seshagiri 'supported liberalization and encouragement of free market forces, Nambiar [was] more in favour of component based growth with emphasis on R&D and indigenous development' (Malhotra 1988)[21].

Therefore it was through Nambiar and those who supported him that pressures against complete liberalisation of software imports were routed, and it is no coincidence that the limitations to stock and sale liberalisation began shortly after Nambiar's appointment as Secretary at the beginning of 1987. Nambiar also supported the local hardware companies which wanted to see hardware imports for software companies remain controlled[22].

Such protectionist views are not limited to the DoE. The Directorate General of Trade and Development has also played a role in policy making and DGTD interviewees stated that it 'might well discourage easy imports' in order to foster its interest in 'boosting local firms'[23].

Balance of payments

The Department of Electronics is the 'recommending ministry' or 'administering ministry' for software policy making and policy implementation, but input to policy is also made by a large number of 'concerned ministries'. Some of the more important 'concerned

21 This differentiation between Seshagiri's and Nambiar's policy objectives is also described by Dataquest (1988c) and Sinha (1988).

22 Though hardware policy is not of prime concern here, it would appear that local hardware companies have had a fair degree of influence in supporting hardware import protection measures. It was disagreements over hardware import policy, and over the question of software piracy, that were largely responsible for the creation of Nasscom as a trade association for software companies, separate from the perceived 'hardware interests' of MAIT.

23 Lall (1984b) also notes the DGTD's interest in opposing imports which compete with local production.

ministries' involved in software policy formulation include the the Ministry of Finance and the Ministry of Commerce (MoC).

One of the dominant concerns expressed by bureaucrats from these ministries is over the balance of payments and the level of foreign exchange reserves[24]. Like those concerned to protect local industry, these bureaucrats are not necessarily opposed to all liberalisation. For example, at a 1985 meeting, the Commerce Ministry representative stated that they were looking for ways 'to liberalise policy and remove constraints' (EEPC 1985), and worries about the balance of payments could lead to support for an export-oriented policy as a means of earning more foreign exchange.

However, these worries more often seem to lead to opposition to liberalisation of imports. At the same meeting, the MoC representative emphasised that there were limits to the outgo of foreign exchange to pay for imports that would be permitted (EEPC 1985), and officials in one section of the Commerce Ministry stated that they wished to ensure 'that foreign exchange is used effectively and not wasted on unnecessary imports'.

Similarly, in 1986, Dr Seshagiri explained that Finance Ministry officials would rather see much slower industrial growth than sanction heavy spending of foreign exchange on imports (EI&P 1986b), and when Seshagiri's concept of 'flood in, flood out' became known, both Commerce and Finance Ministry bureaucrats were said by two senior lobbyists to be unhappy about the idea because they wanted to know 'who is going to pay for the flood in?'.

Within policy making, these views helped support the maintenance of some barriers over software and hardware imports (such as the changes to 'stock and sale' rules); were the driving force behind the increases in export obligations in 1986; led to the imposition of a 15% foreign exchange conservation tax in 1987 which hit the software industry hard; and were also behind the argument which led to a reduction of the foreign exchange permit from 50% to 30% in 1986.

Revenue raising

Like that over foreign exchange and the balance of payments, the concern about government revenue is mediated by particular bureaucrats. Officials in the Ministry of Finance charged with collecting revenue have to try to satisfy the large number of calls on

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[24] It is these bureaucrats who translate the foreign exchange constraint noted above into policy outcomes. Raju (1987) also notes the foreign exchange shortage as a major bureaucratic concern.

government spending[25]. They have therefore always been concerned within policy that as much money as possible should be raised for government. It was the Ministry of Finance which refused to allow a reduction in software import duties from 60% to 25%, as suggested by the DoE in 1986 and which supported the raising of import duties in 1989 and the application of other taxes.

As was the case with foreign exchange, concerns over revenue do not, of themselves, mean that liberalisation will be opposed and Seshagiri wished to argue that liberalisation of import duties would lead to higher growth and therefore greater government revenues from other taxes. However, in the specific measures of relevance to software policy, maintenance of high taxation of all types has generally been the Finance Ministry's wish and this has been the opposite of what those in favour of liberalisation have wanted[26].

Bureaucrats from other ministries, including some in the DoE, have been worried about revenue and foreign exchange issues but these are primarily seen as Finance Ministry concerns. These concerns appear to be more internally generated than deriving from industry. Even lobbyists from the largest software companies stated that they rarely met MoF staff; that it was very hard to discuss policy with them; and that they were the most difficult to try to influence.

Most companies routed their requests about duties and taxes through the DoE because of this difficulty, although the Department of Electronics itself appears to have had only limited influence on the Ministry of Finance. The MoF is seen, according to most bureaucrats and lobbyists, as being very close to the top of the 'pecking order' of ministries[27]. It has had a strong influence on the shaping of policy so that, as one lobbyist put it, 'whatever the DoE wants, the Ministry of Finance can veto it'[28].

Licensing and control

Another interest of certain elements within the state has been the maintenance of control over the functioning of industry. One reason for this is a belief that industry will develop more fully and/or with national needs more in mind if the state intervenes. There are also less ideological reasons. The current research produced no direct evidence of bureaucrats accepting payments in order to grant favours and licences but several interviewees claimed

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25 EPW (1984b) notes the importance of revenue raising over and above other considerations within the Finance Ministry.

26 See, for example, Ravirajan & Jaikumar (1987).

27 Ghosh (1986) also notes the importance of the MoF's role.

28 This is also described by Computers Today (1987d), Dataquest (1988i) and Mathew (1989a). A number of interviewees noted the 'empire-building' that goes on within ministries and the antagonism that can exist between ministries.

that they had paid money in return for bureaucratic services, and a number of writers agree.

> "Battalions of bureaucrats wield the weapons of monopoly control, foreign exchange regulation, industrial licensing and credit and input rationing to keep the industrialists on the defensive and to increase their own political leverage and corrupt income." (Bardhan 1984:58)[29]

These bureaucrats are unhappy that industry should be able to function without coming through or to the bureaucracy because, in that case, they would lose their powers, particularly their ability to demand payment. They therefore wish policy to be made in such a way that industry should deal with the bureaucracy in the normal course of events and that industry should not be able to circumvent this process by misusing policy measures.

Those who wish to maintain licensing and controls tend to be fairly implacably opposed to liberalisation. Despite the fact that the software industry has had one of the most liberalised set of policies, these bureaucrats, in coalition with other interests, have helped to ensure that a large measure of government control has been retained. In 1990, for example, any foreign exchange spending still had to be cleared by the Reserve Bank of India; hardware could only be imported after the granting of a government licence; any firm wishing to sell imported software to other companies had to register with the DoE; and export contracts had to be registered with various government agencies.

Summary and conclusions

The Indian state, like Indian industry, should not be seen as a homogeneous group with uniform interests. Five different interest groups have been identified which made an input to Indian software policy during the 1980s - those in favour of liberalisation; those who wish local industry to grow and be protected; those concerned with the balance of payments and foreign exchange availability; those wanting to raise as much revenue as possible for government; and those who want to maintain state control over industry.

Each group has had different views about policy liberalisation with, for example, most being positive or neutral about a reduction in state controls over industry but only the pro-liberalisers supporting import liberalisation (about which there has been most

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[29] Other writers making the link between bureaucratic activity and bribery include Minhas (1988), Paranjape (1988), Harriss (1989) and Kohli (1989a), some of whom also note the element of conflict between state and industry.

discussion and disagreement). The impact of each set of interests can be seen in the shape of software policy, especially in the continuing controls and taxation that existed in 1990.

Individual bureaucrats may subscribe to the views of more than one interest group but it is the Ministry of Finance bureaucrats and their foreign exchange and revenue-related interests which have often dominated the policy-making process. Staff in the MoF have a powerful role, yet are relatively hard for other bureaucrats or for industry lobbyists to influence.

Only one of the interest groups appears to act on behalf of Indian industry while others are autonomous from (or even antagonistic to) the interests of industry. Such a conclusion is supported by Bardhan (1984:32-39), who points out the inadequacy of views which see the state as the direct or indirect tool of the dominant proprietary class. While one must recognise the 'serious constraint' posed by the imperatives of such a class and its industrial influence, one must also recognise 'the explanatory centrality of states as potent and autonomous organizational actors.' (Bardhan 1984:33)[30].

2.3. Foreign interests and influences

Foreign influences on Indian software policy have come through a variety of mechanisms and from a variety of sources - foreign governments, international organisations, and foreign companies - all of which are discussed below and almost all of which have supported the liberalisation of state policy. Within the limitations of this current study, the extent to which these foreign pressures had actually influenced the making of Indian software policy could not be fully ascertained[31]. However, some influences are clear, as is the fact that influence has generally increased during the second half of the 1980s, at least from foreign companies and foreign government policy.

Foreign government policy

Given that the United States is India's largest software trading partner, it is not surprising that US policy has had the greatest external influence on Indian policy. Some elements of this have already been noted in previous chapters. US Department of Commerce rules mean that the Indian DoE has had to set itself up as an import certificate issuing agency and introduce a further set of procedures into the hardware import process.

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30 This being particularly applicable in India where the state is large, long-standing, powerful and an owner of the means of production.

31 As regards policy in general, for example, BM (1988) sees a considerable foreign influence whereas Harriss (1989) feels that the Indian government has been able to resist external pressures.

This US department has also had to give permission for the setting up of some offshore software development centres, including Texas Instruments (India). Changes in US visa rules and fears about immigration protectionism may also have spurred policy changes in India. The provision of telecommunications infrastructure, including software technology parks, expanded considerably after the visa rule changes in 1989, perhaps partly as a result.

Of possibly much greater significance in the long run has been the American effort to force change in India through '301' legislation[32]. In 1988, section 301 of the 1974 US Trade Act was updated by the Omnibus Trade and Competitiveness Act. It contained two particular provisions of relevance to the Indian software industry - Super 301 and Special 301.

Special 301 was intended to put pressure on other countries to observe intellectual property rights (IPRs) and to take action over software piracy. India (and 24 other countries) was placed on a 'priority watch list' for 'abuse of patents, copyrights, trademarks and computer software' (Polavarapu 1989d) as a result of which the Indian government agreed to negotiate on IPRs within the General Agreement on Tariffs and Trade (GATT) and to try to strengthen anti-piracy legislation[33].

Super 301 was far wider in its compass and permitted the US government to levy tariffs of up to 100% on goods imported from a nation judged to be an unfair trader. India was placed on the Super 301 list and its government threatened with such levies if certain domestic policies were not altered, including those on restrictions to foreign equity, export obligations, the phased manufacturing programme of production indigenisation, and domestic market access[34]. As US Trade Representative, Carla Hills stated:

> "We will open foreign markets with a crowbar where necessary, but with a handshake wherever possible." (Polavarapu 1989d)

By the end of 1990, the US government had only threatened rather than actually imposed import levies, and there had been no specific changes to Indian software policy. However, there were some general liberalisations of the rules on foreign collaborations which 'Many see ... as India's response to the Super 301 threat' (Das Gupta & Taneja 1990).

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[32] Details about the 301 legislation are taken from Enderwick (1989:236), Polavarapu (1989d), Thakurta et al (1989), Basu (1990), Kakodkar-Desai (1990) and Subramanian (1990).

[33] US pressure on foreign governments about IPRs is also discussed by Foremski (1988).

[34] Brazil and Japan were also placed under threat but this was lifted following policy liberalisations in Brazil in the wake of President Collor's election, and following the Japanese government's agreement to negotiate.

The potency of the threats contained in Super 301 comes because of industries like software, with their increasing level of exports to the United States. As the size and importance of these exports grows, so the US government is increasingly able to use threats to these exports as a reciprocal lever to try to force changes in Indian policy.

International organisations

Such a reciprocity is also seen in international fora and organisations such as the GATT and the World Bank. In the post-1986 Uruguay round of GATT talks, the United States representatives and others from developed countries have been concerned to liberalise world trade, particularly in services (Khan 1988, Kirmani 1989). Such trade liberalisation has been resisted by many representatives from developing countries because they feel it would be likely to have a negative impact on their domestic economies (Clairmonte & Cavanagh 1985, Khan 1988, Enderwick 1989:216-19).

However, the growing importance and size of services exports from developing countries, including software exports from India, has led a number of such countries to support moves to reduce services trade barriers (Farnsworth 1989). These developing countries, especially India, have had to accept a link between their desire for continued or liberalised immigration access to foreign labour services markets and the liberalisation of access to their own services markets (Enderwick 1989:235, Malik 1989). With the Uruguay round incomplete at the time of writing, the actual impact of this reciprocity was unclear but the potential to change Indian policy was considerable.

World Bank representatives have used a different kind of reciprocity. They have interacted with Indian government officials and encouraged the liberalisation of a wide range of policy measures, particularly state controls and import policy (Singh & Ghosh 1988, Chakrapani 1989). This encouragement has been linked to the provision of World Bank finance for Indian development projects (EPW 1986), though it is not clear to what extent these pressures have actually influenced changes in Indian policy (Patel 1987:162-63, Paranjape 1988).[35]

Foreign companies

The influence of foreign companies on Indian software policy has already been partly described in chapter 7[36]. These companies have been primarily concerned with achieving

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[35] Patel (1987:162-63) and Singh & Ghosh (1988) suggest that the International Monetary Fund has had a similar interest and influence to the World Bank.

[36] Datt (1987b:190) and Manor (1987) discuss the influence in more general terms.

a greater level of sales in the Indian domestic market and, to a lesser degree, with using Indian labour for software development, principally for export.

In the early 1980s, companies in the latter category wanted a liberalisation of regulations relating to software exports. This has come about in several ways; in the confirmation of application of various liberal rules to export-only software companies; in the general encouragement to foreign investment and the procedural assistance given by Dr Seshagiri, particularly to software investments; and in the alteration of rules on use of telecommunications links to transmit software. Once installed in India, these multinational subsidiaries form part of the spectrum of local influences though, as already described, they have appeared to be fairly content with the liberal nature of policy as it affected them.

Those companies which are more concerned with the local market have pushed for liberalisation of import policy. They sent representatives in the mid-1980s to talk directly with government officials but made greater use of potential local collaborators. Once persuaded of the benefits of distribution collaborations, these local companies helped to lobby for the appropriate changes to import policy.

There have also been pressures because of the reciprocity between exports and imports, with foreign firms linking the provision of markets for software exports to improved local market access, though this had affected hardware imports rather than software imports up to the time of writing.[37]

Other Influences

Non-resident Indians (NRIs) - those born in India but living overseas - have also tried to influence Indian policy, mainly through the Joint Indo-US Scientific Committee on Electronics which was set up in 1986 to provide an NRI input to electronics-related policy, including that on software. NRIs have almost universally called for policy liberalisation (EI&P 1988c) up to and including those who advocate 'let the free market reign' (Dataquest 1988j). The influence of NRIs on Indian policy is unclear but, at least according to two or three bureaucrats, it has not been particularly great.

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[37] The issue of hardware import policy is further complicated once foreign firms start manufacturing in India. They then turn from wanting open imports of computers to wanting liberal import of sub-assemblies and peripherals but protection from computer imports.

Summary

External influences on policy making in India have come from a variety of sources including foreign governments, international organisations, and foreign companies and their collaborators. Almost all of these have sought to encourage policy liberalisation, though foreign companies have also enjoyed the benefits of state intervention.

It is the companies which have had some of the clearest influences on Indian policy in the 1980s though all foreign influences grew during that time and, by 1990, were in a much stronger position to force liberalisation on India. Much of this strength derived from the increasing role of exports, foreign collaborations and foreign investments in India, all of which were used by external groups as levers of change.

2.4. Policy interest groups and policy phases

As discussed in chapter 2, Indian software policy, like most Indian industrial policies, has gone through a series of phases since 1984 in relation to liberalisation. While the 1984 policy contained a number of liberalisations, the only major liberalisation in the 1986 policy was the delicensing of software imports and, after 1986, there were only modifications to policy, which seem to have been largely independent of any overall liberalisation thrust.

There has variously been a slowing or stopping or reversal of the liberalisation trend, with the end result by 1990 being only a partial move to liberalisation, in which there were some reductions in duty, some easing of procedures, some use of delicensed imports, but also maintenance of other duties and plenty of state intervention in the form of licences and registrations. Given a knowledge of the interest groups which play a role in the formulation of policy, some attempt can be made to explain the phases and outcomes.

There has been a broad division over policy liberalisation into three groups - supporters, opposers, and those who support certain liberalisation measures but oppose others. Supporters included Rajiv Gandhi, Dr Seshagiri, a number of other ministers and advisers, some sections of the software industry, and all external influences[38]. Opposers included those bureaucrats who wanted to maintain the system of licensing and controls.

The variable-view group includes the powerful influences of the largest software companies and of those bureaucrats, mainly in the Ministry of Finance, who are concerned

[38] This type of grouping is also described by Manor (1987).

about loss of foreign exchange and/or loss of revenue[39]. It also includes domestic-oriented software producers, hardware companies, and those wanting to protect local industry, who may support some removal of bureaucratic controls but generally oppose import liberalisation.

Given this balance of interests, one could easily imagine that the eventual outcome should have been a policy that was partially liberalised, yet still partly interventionist and protective. However, in addition to this static view of interest groups, there has been a dynamic process of change.

Liberalisation was not a smooth, continuous process but was proposed as a series of discrete policy elements. Some of these elements were supported by a dominant coalition of interest groups and some were not. The extent of support depended on the type of liberalisation proposed but also on the nature of the 'dominant coalition', which has changed over time as described in the following sections.

1984-85

In a broad sense, the move towards policy liberalisation in the late 1970s and early-mid 1980s derived from the observation that the industrial growth rate was declining and that there was widespread public sector inefficiency. Some commentators argued that the required policy responses were an increase in public investment and a resurgence of planning (see Harriss 1989). However, the stronger view was from those who saw policy liberalisation as the answer.

Managers in many Indian industrial firms were in favour of liberalisation at that time because they felt hampered by protectionism, particularly by state controls and by the problem of access to imports. There were also pro-liberalisation pressures, of uncertain importance, from foreign companies, governments and international organisations. However, the drive to liberalise came principally from within the state with other groups, including industry, being reactive rather than proactive.

According to Kohli (1989a), a number of ministers and advisers inclined towards liberalisation because of their (arguably mistaken) association of the Newly Industrialised Countries' economic growth with liberalisation; because of 'the fact that major communist countries like the Soviet Union and China seem[ed] to want to embrace the market'; and because a number of them had received their education and training in American

[39] The latter group have opposed most of the liberalisations of importance and so could arguably be put in with the 'opposers'. Their opposition to some DoE-proposed liberalisations is noted by Dataquest (1988i).

universities and institutions such as the World Bank, in which policy liberalisation was seen as the correct strategy to be adopted[40].

Ideology, however, was not enough. What was also needed was political power and Rajiv Gandhi's administration was in a strong position in late 1984, based around natural sympathy over his mother's assassination which materialised as a landslide electoral victory. This victory 'freed Rajiv Gandhi - if only momentarily and artificially - from coalitional entanglements and interest group pressures. ... Situations of state autonomy like this encourage the powerful to pursue their ideological whims.' (Kohli 1989a).

This, indeed, they did. At a general level, the Prime Minister, Finance Minister V.P. Singh and other senior politicians and advisers were pushing forward a liberalising viewpoint. For software policy, Dr Seshagiri made use of the sympathetic atmosphere from the Prime Minister and others to enact his ideas on liberalisation. Such was the force for change that many bureaucrats who completely opposed liberalisation kept silent in this period, and those who subsequently opposed complete liberalisation often spoke up in its favour.

1986

It was Rajiv Gandhi's intention to maintain this condition of state autonomy and to 'de-politicize India's public life. 'Power brokers' and political bargaining were supposed to decline radically in importance in the industrialised sector of the economy' (Manor 1987)[41]. By 1986, however, it was clear that this had not been achieved. In software, for example, foreign influence was slowly growing and the software industry itself was more organised, slightly more proactive, and had a wider set of mechanisms through which to make government officials aware of its opinions (Computers Today 1986c, Menon 1987).

Software policy was discussed throughout the year, with government officials being lobbied by and listening to local and foreign interest groups, and even organising meetings and committees to enhance this process. Many liberalisations were still proposed but interest group reactions to them were gauged and revisions and compromises made accordingly (EI&P 1986b).

As well as a change in the balance of power between the state and other groups, there were also changes within the state which meant that liberalisation was not as widely supported as it had been. By late 1986, V.P. Singh was on the point of leaving the Finance Ministry

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40 The last point is also made by Patel (1987:162-63).

41 This process is also described by Rubin (1985).

(Harriss 1987, Rothermund 1987) and MoF bureaucrats felt they had more freedom to voice their opposition to liberalisation measures which might decrease revenues or increase the balance of payments deficit. They had become particularly concerned at the high level of imports that earlier liberalisations had permitted and wanted to alter this situation if they could[42].

At the end of the year, Nambiar arrived as the new Department of Electronics Secretary and was both more powerful and less inclined towards liberalisation than his predecessor. His interests and those of like-minded bureaucrats were often set against those of Dr Seshagiri, who was still in office and, assisted by the influence of foreign companies, was still trying to urge liberalisation.

Within the local industry, the interest groups and their strengths did not alter but the liberalisations being proposed now went beyond those of 1984. Not all the possible liberalisations, for example those on imports and encouragement of foreign collaborations, therefore received the wholehearted support of industry, particularly of the largest companies.

Therefore, by 1986, the balance of power between the coalitions of interest groups had shifted. The small group within the state which had been pushing liberalisation had become somewhat dispersed and distracted, and was no longer so isolated from outside pressures. Overall, those in favour of total liberalisation were no longer dominant and those who were increasingly dominant were no longer in favour of total liberalisation. Instead there was a much more even balance between those supporting and those opposing liberalisation. Hence, the final policy both moved towards and away from liberalisation in its various measures[43].

1987-1990

From 1987 onwards, the Prime Minister and a number of his advisers became more interested in political rather than policy matters[44]. One senior bureaucrat found that, although they were still keen to promote both liberalisation and the software industry, these senior officials could not devote time or energy to seeing changes through. Other officials who had been in favour of liberalisation were no longer in positions of power -

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[42] See, for example, Raju (1987).

[43] One element that helped the passage of software import liberalisation was the relative lack of a strong lobby of local software package producers. By contrast, the strength of local hardware producers was such that they were able to water down import liberalisation even in 1984 (EPW 1984b, Computers Today 1985a, Dataquest 1985).

[44] Particularly following the defeat of the ruling Congress (I) party in Haryana in May 1987 (Kohli 1989a).

V.P. Singh and like-minded politicians and advisers had left the government and Dr Seshagiri's power was waning.

Seshagiri had been very much in favour with the industry in earlier years when his concern for liberalisation was in tune with the majority view in the industry, but he fell from grace for the same reason. He genuinely believed in the validity of his viewpoint and was not willing to modify it because the dominant industry groups now wanted something rather different.

Those in the Department of Electronics who opposed total liberalisation also began to look for ways to reduce Seshagiri's powers. After a year of internal and external battles over the extent of liberalisation, Seshagiri made public his views about those opposed to complete liberalisation once too often (in Hutnik 1988c). The resulting disagreement with Nambiar led to Seshagiri moving sideways out of the DoE to head the National Informatics Centre in early 1988[45].

Software policy making in the late 1980s was therefore dominated by two groups - the very large software companies and the Finance Ministry bureaucrats concerned about loss of foreign exchange and loss of revenue. These groups do not appear to hold any fundamental or ideological opposition to liberalisation *per se.* They have their own set of interests which are largely independent from the interests of the other but also separate from the agenda of liberalisation. Their support for or opposition to individual policy measures depended on how the measures fitted in with their interests[46].

The image offered by some lobbyists for policy making after 1987 was that of the headless chicken. Policy ran in the direction dictated by the strongest coalition of interests but had no overriding, planned direction, especially in terms of any structuralist...neo-liberal axes. Only entrepreneurs, traders, and increasing foreign influences were left to support liberalisation.

One of the reasons behind the lack of any major software policy initiatives since 1986 has been the loss of an overriding direction for policy with the state becoming more reactive than proactive. It also derives from the desire of many government organisations to alter policy without having to go through the lengthy process of compromise and input from other groups. They can only do this by issuing modifications to existing policy, or by using

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45 As Hutnik & Jaikumar (1988) commented, 'There are new forces at work in the DoE ... With Seshagiri no longer involved in policy formation one of the leading proponents of free market electronics development has lost his voice'.

46 These interests may coincide, and the large companies have often been adept at manipulating bureaucratic *concerns to get policy altered in* the way that suits them. For an example addressed to software imports and fears about loss of foreign exchange, see Hebalkar (1987).

those individual measures which are within the control of a single ministry or organisation and which, particularly, avoid the necessity of input from the Ministry of Finance.

Summary

The changing phases of software (and other industrial) policy can be largely explained by the changes in the coalitions of interest groups which make an input to that policy.

In 1984, a group within the state was able to act largely independently of other interests and push through an agenda of policy liberalisation. Autonomy did not last and by 1986 this group was having to deal with other interest groups in the state and industry, and having to compromise on liberalisation. By 1987, those who had championed liberalisation within the state no longer had a major influence on policy making. Policy measures could therefore respond to industry needs but had no underlying direction.

The liberalisation thrust of the mid-1980s was therefore brought to a virtual standstill, with there being only very tentative signs of a revival in 1990 thanks at least partly to growing pressure from external influences. These were emerging as almost the only proactive influences with a clear agenda for policy change.

3. Conclusions

> "Much of the literature dealing with state intervention in the area of technology in the Third World implicitly incorporates a model of the 'state as rational subject', choosing objectively the path that leads to maximal social welfare of the nation." (Fransman 1986:103)

The study presented here suggests that this view is incorrect and that, to understand policy making, one must analyse technical and financial constraints, political interests and power (Fransman 1986:104), and avoid the 'neo-classical approach [which] abstracts the economic from the social and political dimensions of the analysis.' (Evans & Alizadeh 1984)[47].

From this perspective, it emerges that not only does the state often act in its own interest, and not on behalf of industrial or commercial capital, but that both state and industry are heterogeneous and contain several different interest groups. Policy making in this

[47] A point also made by Bardhan (1984), Harriss (1987), Kabra et al (1987) and Guha (1990a).

instance is therefore a thoroughly political process, much as Lindblom's (1968) model describes. Policy is normally made by a process of formation and action of coalitions of interest groups and by a process of negotiation, bargaining and compromise between these groups.

The policy that results is therefore a compromise rather than an objectively 'best' policy, with enacted policy measures all having to pass through filters of technical, financial, bureaucratic, industrial and, above all, political feasibility. Any 'objective' cost-benefit analyses are used, if at all, as weapons by those involved to support their own viewpoint or attack that of others.

Because of the constraints and the compromises, policy making becomes a conservative, iterative process with policy changes being incremental[48]. This type of process is inimical to both radical and uniformly-applied policy change.

The only exception to this model of policy making in India has occurred when one of the groups achieves a temporary autonomy which enables it to enforce changes according to its wishes alone, as did a section of the Indian state in 1984 and 1985, when it was able to make a start on a programme of radical change. However, it was unable to sustain this and soon had to return to the process of negotiation and compromise.

'In these circumstances, admonitions to Developing Countries to emphasize rapid and fundamental policy changes may be of little practical relevance.' (Johnson 1990), and such admonitions are naïve if they do not recognise the limitations imposed by political, technical and financial feasibility.

This is particularly applicable to the neo-liberal model, which expounds quite radical policy prescriptions with the intention that they should be uniformly implemented by Third World governments (World Bank 1987, Chakrapani 1989, Colclough 1989:12). Such prescriptions cannot be wholly introduced into India because of the need for political compromise; because of the inevitability of government intervention in the market given the political demands made on it; and because of other constraints (Guha 1990a:5, Guha 1990b:42)[49]. Only if India had had 'a much more authoritarian regime, able to ride over the powerful interests represented in the dominant coalition.' (Harriss 1987) could widespread, radical policy liberalisation have been a viable possibility.

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48 This may be problematic for high-technology industries trying to respond to rapid macroeconomic and technological change.

49 Harriss (1989) also describes how radical socialist policies could not be introduced after independence because of the nature of India's polity.

The software industry presents a prime example of the fate of liberalisation in the Indian context. Liberalisation in this industry has progressed further than in most other industries thanks to the strength of those groups which supported it. However, the opposite is also true. Even in an industry like software, which might have differed from other Indian industries by being new, entrepreneurial, and high-technology- and export-oriented, the liberalisation thrust has been slowed, if not stopped. Far from being a special case or a new model for Indian industry, software has followed the policy-making pattern of other areas.

This analysis also indicates the possible country-specificity of policy models, as suggested in chapter 1. The South Korean and Japanese states, for example (Bardhan 1984:71-74, Evans & Tigre 1989), appear to have had a homogeneity that the Indian state lacks, and to have been more able to avoid the enmeshing of economic management and the political process, and the need to contend and compromise with various interest groups in the way that the Indian state has had to.

Realistic policy prescriptions should therefore be neither radical nor intended to be uniformly applied because '... industrial policy cannot be viewed in isolation from several broader issues' (Weiss 1988:306) including the autonomy and political basis of the state, the competence and honesty of the bureaucracy, the macroeconomic environment and finance availability, and the technology base and technological capability of the industries concerned.

However, the findings here indicate a difficulty in trying to apply this type of industry-specific policy. Within the present framework, formalised policy making for individual industries has to take in a wider set of views because of the many government officials who make an input to industrial policy, including Ministry of Finance and Ministry of Commerce bureaucrats[50].

This forces some compromise of the policy needs of any individual industry with those of the rest of the economy. It also explains why ministries such as the DoE try to use *ad hoc* policy decisions and implementations where possible in order to avoid having to compromise with other groups, and in order to try to achieve their own policy-making autonomy.

The findings in this chapter also suggest that, in normal circumstances, chosen policy directions will have a tendency to be self-reinforcing because policy measures will help to

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[50] Who have felt, at times, that the software industry has been too small to justify specific policy concessions or that offering concessions to one industry will bring a host of demands from other industries that they be treated in the same way.

create interest groups which will lobby for a continuation and extension of similar policy measures. There is therefore a partial feedback loop between industrial policy and the political structure of both government and industry.

Hence, for example, the way in which 'stock and sale' policy would be hard to alter because of the distributor lobby that it built, but also the way in which the polity created by many years of state controls helped to limit and even reverse some liberalisations of the mid-1980s[51]. This process of self-reinforcement is particularly important when the state *moves from relative autonomy* to *relative* dependence as it did during the second half of the 1980s, because in such circumstances, policy becomes increasingly shaped by forces outside the state, which the state itself may have initially helped to create when it was more autonomous.

Self-reinforcement has also been a characteristic of the Indian software industry's export orientation. The reliance on import-led exports has meant that, as imports rise, so exports must rise to pay for them, and so imports must rise again, forcing a further drive to boost exports, and so on. The significant entry of foreign-owned firms into the Indian software industry in the mid-1980s has also left them and related policy measures firmly entrenched.

Perhaps more importantly, export orientation has also helped to increase the external pressures on Indian software policy. These pressures are much further outside the control or influence of the Indian government than local industry (including local multinational subsidiaries). In the future, then, these external pressures could increasingly be the relatively autonomous driving force behind Indian policy making.

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[51] Described in more general terms in EIU (1986:102) and Harriss (1989).

CHAPTER 10

OVERALL SUMMARY AND CONCLUSIONS

Introduction

This chapter brings together the conclusions from previous chapters in summary form and addresses them to the issues of policy, liberalisation and software industry development in India.

The question that has guided this research was set out in chapter 1:

How has the development of the Indian software industry been affected by liberalisation of state policy?

Policy liberalisation has been the practical prescription deriving from the neo-liberal theoretical model and the primary aim of this study has been to consider the impact of this prescription on the development of an industry that is relatively new, rather different from other industries, but also increasingly important to developing countries.

Despite the recency of this industry and its orientation to exports and new technology, and despite the fact that software is probably the most liberalised of all Indian industries, in this chapter it will be argued that policy liberalisation cannot be regarded as a 'panacea' for software industry development. This is because all the impacts associated with liberalisations are not unquestionably associated with long-term industrial growth; because policy is not the sole determinant of industrial development; because government intervention has proved to be a necessary part of industrial development; and because certain liberalisations may be unfeasible. Nor can export orientation be seen as a 'panacea' for software industry development since it too, has a number of associated shortcomings.

Guidance on industrial development cannot, therefore, derive dogmatically from the individual theoretical models described in chapter 1, but must be geared towards the particular circumstances that affect the industry at any given time. Industrial policy needs to mix intervention and liberalisation, export- and domestic-orientation, and be detailed, specific, co-ordinated and, above all, responsive to change.

This chapter concludes by offering some specific suggestions on possible changes to Indian software policy, on guidelines for software industry policy in other developing countries, and on possible future research.

1. Liberalisation and software industry development

Before summarising the relevant findings from this work, three points are worth noting. Firstly, some of the policy measures described were, at the time of writing, only relatively recent and policy is continually changing. Therefore, this should be seen as a report on an ongoing process of development rather than as a definitive and final analysis of the Indian software industry's development.

Secondly, it needs to be recognised that state industrial policy exists as a series of explicit or implicit industrial development objectives. The impact of these policy objectives is mediated much more by what state officials actually implement than by what is written on paper (see chapter 2.2). The perceptions of industrialists are also important and so policy affects industrial development by the form of policy and of policy changes as well as by its actual content (see chapter 4.2.1).

Thirdly, the relationship between software and hardware technologies is such that any consideration of software industry development would be incomplete without a complementary consideration, as detailed in chapters 5 and 6, of hardware industry development. The results presented here therefore necessarily include findings about the development of both the Indian software and hardware industries.

1.1. The impact of liberalisation on industrial development

Predictions from theoretical models

In chapter 1, two models were described - the structuralist model and the neo-liberal model - which would predict quite different industrial development impacts for liberalisation.

The structuralist model predicts that liberalisation will bring a loss of skills, competitiveness and long-term growth prospects; balance of payments problems; a manifestation of constraints which liberalisation itself will not be able to overcome; a dependence on foreign capital; and a skew of the local economy to foreign demands.

The neo-liberal model, on the other hand, predicts that liberalisation will lead to growth in efficiency, output and the industrial base; a balance between export and domestic sectors; a production pattern in line with comparative advantage; and a supply of scarce inputs from external sources.

The two models also disagree over sector-specific policies, from which the structuralist model foresees overall benefits, while the neo-liberal model does not. In the sections below, these predictions will be compared to the observations of Indian software industry development.

Questioning the simple, aggregate picture

As described in chapter 2, software policy has been liberalised in India throughout much of the 1980s. At the same time, as described in chapter 3, aggregate estimates of industrial growth - production output, exports, jobs, number of firms - have all grown strongly. Despite this, there is no simple and positive relationship between growth and liberalisation for two main reasons.

Firstly, because by looking in more detail at the measures of industrial growth, one sees a rather different picture, as shown in chapter 3. There have been comparatively low overall net earnings from exports; a negative balance of trade in software; major staff losses overseas (the 'brain drain'); and high industrial concentration.

The majority of exports are also subject to an international skill and locational division of labour such that they consist of relatively low-skilled, onsite software services undertaken for a single US client. This division of labour has helped to reinforce the brain drain, to increase vulnerability to external changes, and to limit long-term growth particularly because it entails a failure to obtain the higher-level analysis and design skills which will be crucial to future industrial growth.

There have therefore been a series of imbalances in this industry's development, as detailed in chapter 4. There is an imbalance between export and domestic production, with export work being much more attractive in terms of revenue, profits and skills than domestic market work, and with the latter being characterised by high competition and poor work quality. There is also an imbalance between large and small firms, such that small firms have had great difficulty achieving growth; and between services and goods production, such that software packages make up a very small proportion of the Indian software industry's overall output.

Secondly, there is no simple relationship between liberalisation and industrial growth because 'liberalisation' does not adequately describe the process of policy change outlined in chapter 2. Although software policy was one of the most liberalised industrial policies in India during the 1980s, it never approached a neo-liberal model of policy. Software policy liberalisations began in the 1970s, gained strength in the mid-1980s, but then faltered.

The progress of liberalisation was also radically different in different areas of policy. For example, while software policy in 1990 could be described as liberal or fairly liberal as regards industrial entry and software imports, there were still important controls on foreign collaborations and hardware imports, and substantial state interventions in the provision of finance, training and infrastructure.

One cannot, therefore, take either industrial data or industrial policy at face value. There is a need, when dealing with software industry data (or that of any other industry) to 'look behind the figures'. This, and the differential application of liberalisation to varying policy areas, necessitated a more in-depth study than an aggregate view would provide.

This greater depth of study took up the analysis of liberalisation from chapter 1 to focus on a number of policy areas, including the encouragement or otherwise of foreign investment; the degree of state involvement in industrial development; import barriers; and the extent to which industry was oriented towards exports. The first three will be dealt with below, while export orientation will be discussed in a later section.

Foreign collaboration and investment

In chapter 7, it was seen that foreign collaboration should not be characterised solely in terms of foreign ownership and direct investments because it occurs through a wide variety of relationships. The three main forms described in chapter 7.3 were informal relations with foreign contracting agencies (which involve only very limited, indirect investments), semi-formal relations with foreign hardware companies, and relationships involving substantial control by a multinational corporation.

Although it was also seen that the encouragement of foreign collaboration involves indirect government interventions, this encouragement has been primarily associated with the process of policy liberalisation, and can be assessed in this context. Given the software services and export bias within the Indian software industry, collaboration with foreign companies has been a vital part of the industry's growth because it provides assistance in market access, marketing, and in the building of client relationships and credibility (see chapter 7.3.3).

Some, though not all, collaborations have also provided early awareness of new technologies, and investments of capital, technology and skills which have helped individual Indian companies to start to overcome the persistently-observed pattern of export production which is low in capital-, technology-, skill- and marketing-intensity.

From the perspective of those Indian firms which have chosen to ally themselves with foreign companies, and from the perspective of export orientation, many of these relationships have therefore been welcome and seen as both necessary and positively developmental.

On the other hand, as chapters 7.3 and 7.4 describe, some multinational collaborations (including investments) do not provide significant inputs of technology and skills, and do not help to alter the persistent division of labour. Viewed from a perspective wider than that of some Indian firms and wider than that of simple export orientation, one also sees that what foreign investments of skills and capital there have been often remain within the 'enclave' of Indian software export production and are rarely transferred to the Indian domestic economy.

Collaborations may also lead to a loss of profits, intellectual property rights and software package revenues for Indian companies; a loss of staff through both external and internal brain drains; and may lead to rising income inequalities. The collaborations are geared to spreading foreign consumption patterns and to using Indian labour to increase sales of foreign goods. Not only have these goods been developed to address Western business requirements rather than Indian domestic needs such as rural and agricultural development, but the collaborations also involve a large opportunity cost by diverting Indian labour away from addressing such needs.

Finally, collaborations should be judged not merely on their production impact, but also in terms of their effect on the Indian industry's 'locus of control'. In chapters 7.3, 7.4 and 9.2.3, collaborations were seen to lead to a loss of self-determination and choice at the level of the individual Indian company, the whole industry, and the future direction of the industry as embodied in government policy making. Indeed, Indian companies have been used as 'Trojan horses' to promote the views of multinationals from within the Indian political economy.

From all this, one can draw no simple conclusion about foreign collaboration or investment and, to the extent to which they are linked, about liberalisation. As predicted by the neo-liberal model, encouraging foreign collaboration has provided much-needed production inputs and been an essential part of the Indian industry's export-oriented growth. Yet, as predicted by the structuralist model, collaborations have also fostered dependence on external sources of technology, skills and market access; a loss of self-determination; and a vulnerability of future industrial growth.

Increasingly close collaborations are marked by increased growth and investment in skills and technology but also by increased dependence and vulnerability, reduced choice or control for the Indian partner, and fewer links to or from the domestic economy. Thus, neither of the models described is individually adequate to deal with the practical complexities of relationships with multinationals.

For an export-oriented software industry, foreign collaborations may be an essential part of growth but the dependence and vulnerability described give cause for concern and suggest the need to monitor and manage these relationships in a way that would not be possible if development were just left to market forces.

Therefore, while a policy of liberalisation is not sufficient to deal with foreign collaborations, the impacts described show that ideas about such collaborations must go beyond being simply 'for' or 'against', and that they must be dependent on circumstance. For example, while collaborations are vital to export orientation, a domestic-oriented software industry would have less need of them.

Import liberalisation and other state controls

As described in chapter 4.2.1, the liberalisation of state controls on industry has been a necessary aid to greater industrial efficiency and growth. Similarly, chapter 5 indicates the way in which import liberalisation has been a necessary step in bringing about greater use of imported technologies. This, in turn, has helped to overcome the technological barriers to offshore software development; to reduce the price and technological lag of technology available within India; to increase the productivity and quality of software production; and to increase exports. Import liberalisation has therefore been an important part of the Indian software industry's export orientation, backing up the 'flood in, flood out' concept.

However, in both these cases, the process of liberalisation has been akin to opening one of several gates; while necessary, it is not sufficient in itself to cause change or to wholly explain the developments observed, some of which have also been assisted by interventions, such as government purchases of hardware. Nor can import liberalisation be regarded as a comprehensive solution to the problem of raising levels of use of new technology. As pointed out in chapter 5.1, complementary interventions to address marketing, legal protection, and the provision of finance and skills will also be required.

Chapters 5 and 6 show that what import liberalisation has also (though, again, only partially) assisted is an increase in India's dependence on external sources of technology and a growing balance of trade deficit, thus highlighting the limitations of the neo-liberal 'flood in, flood out' concept, at least for software. While import liberalisation has stimulated some local innovation through the reverse functional engineering of software described in chapter 6.1, this is under threat and the greater impact of import liberalisation has been a suppression or stunting of local research and development and local technological capabilities.

For local consumers, then, import liberalisation has been generally beneficial but for local producers, it has been of benefit only where it has improved their access to production inputs (i.e. when they are consumers) and generally not when it has opened up direct competition from final products. One should also remember, as chapter 6 shows, that one industry's inputs are often another local industry's final products, so that a broad perspective must be taken in assessing the impact of import liberalisation.

In summary, the liberalisations described have assisted some software industry growth and some consumption-related developments, but have also hindered production-related developments by increasing the industry's dependence and by harming the development of local capabilities.

High levels of import protection may not always be desirable and liberalisation of industrial controls may have positive developmental consequences, but this does not mean that liberal import regulations are by any means a guarantee of industrial development. By contrast to liberalisation, import protection has proven to be a necessary part of India's hardware industry development to date, and software capabilities have only developed where they are not in commercial competition with imports.

Therefore, as was the case with collaborations, any perspective which is either 'for' or 'against' the liberalisations described must be seen as inadequate. Import protection will play a role in industrial development but so, too, may some liberalisations, albeit a limited role.

1.2. Placing the role of policy in perspective

Despite its main interest in policy and liberalisation, this thesis has clearly shown, throughout all the chapters, that an understanding of industrial development cannot be based on state policy alone because the relationship between Indian government policy and industrial development has been only a partial one, such that policy is not the sole or direct cause of many observed developments. A number of factors which lie outside the realm of 'policy' and which affect industrial development are described below.

Firstly, foreign government policies, especially those of the US government relating to exports and visas, have affected imports and the extent of offshore software development in India (see chapters 4.1.3, 5.1.2 and 9.2.3). The growth of an export-led industry also remains crucially dependent on the state of the world economy.

Thirdly, in chapters 4 to 6, the technology involved and the process of technical change were seen to be important determinants of the type of software production undertaken; of the price of technologies in India and, thus, their use; and of entry barriers into production. For example, as shown in chapter 5, technology imports have been raised and small firm production entry barriers lowered because of the advent of PC-based fourth generation programming languages. The relation between software and hardware technology has also been a significant force shaping the development of the Indian software industry and its foreign collaborations (see chapters 3.1 and 7.4).

Fourthly, the relations between producers and consumers of software were seen in chapters 4 to 7 to have played an important part in determining the nature of the international division of labour; the growth of both exports and collaborations; and even the level of technology imports. Such relations need to go beyond just trading because they require the integration of separate services and goods into a final product, and an understanding of corporate needs; and because they require an assurance of access and control over skills, products and production of adequate quality (see chapter 7.2).

Finally, the Indian software industry's development has also been shaped by the nature of the markets it seeks to address and from which it seeks its inputs. In relation to both export- and domestic-oriented production, these markets are not 'free', but contain barriers, which prevent entry into certain types of production, and constraints, which prevent changes in the pattern of industrial development.

Many examples were described, which include the problems of building credibility, product quality and trust (see chapters 3.6 and 4); the difficulty and cost of marketing (see chapter 4.1.3); the lack of available skills, capital and technology (see chapters 4.1.3, 4.2 and 8.1); and the small size and poor quality of demand from the domestic market (see chapter 4.2.2). All of these have been significant determinants of the Indian software industry's development.

For example, these barriers and constraints have helped to produce and maintain the international divisions of labour already described and a rate of industrial growth lower than that which would otherwise have been achievable. They have also helped to reinforce the persistent imbalances in the industry's output profile which have favoured software services, exports and large companies rather than software packages, domestic-oriented production and small firms.

There are two possible (and not mutually exclusive) ways in which these barriers and input constraints can be addressed. Either the state can intervene directly itself and/or it can encourage the intervention of the multinationals, though this encouragement has also involved some government intervention. Before the impact of these possible solutions is reviewed, two conclusions can be drawn for industrial policy.

Firstly, the limitations of policy must be recognised - because of the 'non-policy' factors described, policy cannot precisely guide an industry's development, particularly when many of the firms are private sector and therefore more removed from government control than public sector firms. Additionally, policy prescriptions must be based on an adequate understanding of the markets within which the industry is operating, and of the nature of the technologies involved, of producer-consumer relations, of the macroeconomic setting, and of foreign government policy.

1.3. Government Intervention

While the thesis question focused on liberalisation, it is clear from the sections above, from the policy descriptions in chapter 2, and from the analysis of policy impacts in other chapters, particularly chapter 8, that policy interventions have played a continuous and necessary role in the development of the Indian software and hardware industries. It is especially significant that even in an industry like software, which has been much newer and more export-oriented, liberalised and entrepreneurial that most of Indian industry, state intervention still has a vital role to play in industrial development.

There are many different forms of intervention, covering those which protect and control as well as those which aim to reduce market entry barriers and improve the supply of production inputs. The impact of most of these, as described in chapters 6 and 8, has been to provide inputs of finance, skills, marketing assistance and infrastructure; and to expand local markets and capabilities through procurement and then protect them from imports.

This has helped to raise the capital-, technology-, skill- and marketing-intensity of production; to somewhat improve the balance between domestic- and export-oriented production; to overcome barriers against offshore software development; and, at the time of writing, to just begin to address the specific imbalances against software package production and against small firms.

As an example, interventions have helped to encourage growth of local production and local technological capabilities by creating and protecting markets for local goods and services. This has, in turn, helped to reduce prices. The size and innovation of local hardware production owe much to government interventions and are an indicator of what demand and protection policies can do, with some Indian hardware firms producing innovative products ahead of all foreign competitors (chapters 6.2 and 6.3).

In software, too, one sees from chapter 8.7.3 that government procurement has increased revenues, skills and credibility for local producers. Similarly, government intervention on copyright is the main way in which piracy can be addressed, and in which its impact of discouraging investment, innovation and technical development can be combatted (see chapter 6.1).

In addition, intervention in the form of import protection has led to a reduction in dependence on multinationals and has compensated for a lack of scale economies brought on partly because of export market barriers. The government has also helped to set up the required organisational forms to deal not only with market entry barriers, but also with the formation and implementation of industrial policy in general, including a permanent body - the Department of Electronics - which has assisted software industry development for more than twenty years.

Interventions have been needed because liberalisation, in any of its forms, has been unable to overcome the barriers and constraints described. Indeed, by assisting new technology import and by encouraging export growth, certain liberalisations are likely to make these constraints increasingly manifest.

As already noted, constraints can mainly be addressed by multinational or state action. By comparison to multinational intervention, state intervention has been more beneficial for the provision of finance and skills to the domestic market; for domestic-oriented production in general; for the satisfaction of basic domestic needs through development of rural and agricultural applications; for independent development; and, possibly, for small firms, software package production and a reduction in the brain drain. It also provides a solution to some of the problems created by multinational collaboration.

This case study therefore demonstrates, in chapter 8, that software industry development need not and, indeed, cannot rely exclusively on multinationals to address market barriers and constraints. Because of this, there are clearly important inadequacies in the neo-liberal model, given that it has tended to play down constraints, which are seen here to be particularly significant, and yet that it cannot provide an adequate solution to them.

The credibility of the neo-liberal model is further undermined by its tendency to focus on price factors and its commensurate uni-dimensional view of the state as an economic actor utilising fiscal instruments. In chapter 4, the importance was emphasised of non-price factors in software industry development including skills, quality, timeliness, access to new technology and to markets, credibility and other elements of producer-consumer relations. Some of these help to explain why the price benefits of highly-skilled, offshore work have not been very widely taken up; and why firms have not relocated to cheaper labour sites.

They also partly explain why the state has had to take on a multidimensional and diverse role in relation to industrial development; a role which includes economic policy processes but which also covers co-ordination and provision of skill and technological infrastructures, as well as direct software production. All of these findings suggest important inadequacies in the neo-liberal model.

This is not to argue that state intervention can be seen as perfect or as the sole prescription for industrial development. Indian government interventions have at times been slow and characterised by inter-agency disagreements. Until very recently, there has been little spin-off from public R&D funding and from state procurement into the private sector (chapters 8.4 and 8.7) and, as illustrated in the case of hardware imports and software export incentives, some interventions have initially appeared to lack a full understanding of all the likely impacts (see chapters 4.2.3 and 5.1). It is also possible that some types of import protection intervention help lead to local production inefficiency and technological lag (see chapter 6), and to unproductive, rent-seeking behaviour (see chapter 5.1).

It would therefore clearly be wrong to advocate developmental paths based either on 'all state' or 'all market' (or 'all multinationals') because both will be required. It may be advisable, for instance, as suggested in chapter 8.9, to divide the provision of inputs between the state and the multinationals. However, it is equally clear that any role for the multinationals must be very carefully considered because it is only in the matter of providing an export market that multinationals have clearly provided what the state cannot.

Government interventions will certainly be a necessary part of software industry development and would do well to follow those of the Indian government which have been iterative and responsive to their own shortcomings and to the changing needs of the software industry as it has developed.

1.4. Constraints on policy making

For many developing countries, the policy prescriptions that derive from the models outlined in chapter 1 represent a requirement for relatively uniform and radical policy change. Yet this study has revealed, through an understanding of the nature of policy making, that such radicalism and uniformity cannot be a part of realistic policy prescriptions for industrial development.

As shown in chapter 9, policy making involves the interplay of economic, social and political factors. Policy options cannot, therefore, be externally imposed because policy has to be made within the boundaries set by a series of constraints, and as a process of bargaining and compromise between interest groups. Separate interest groups can be identified, not just because the state is able to act with some degree of autonomy from industrial interests but also because both state and industry are themselves heterogeneous.

Even in a new industry like software, which has been significantly liberalised and export-oriented, and in which there are many entrepreneurial producers, the process of policy liberalisation has been arrested by various interest groups. Far from being a 'special case', then, software policy has followed the pattern of other industries.

The government does have the ability to alter the political constraints, as its encouragement of exports, foreign collaboration and, hence, foreign influence has illustrated. However, the ability to change has so far been overshadowed by a conservatism and self-reinforcement which has seen the continued influence of certain sections of both state and capital. For example, from almost all chapters it has become clear that the large Indian software companies have tended to benefit more than small ones from all types of policy change - both interventions and liberalisation (though in the latter case this has often been because they are able to form trading relationships which go beyond the free market).

There are also policy-making constraints apart from political ones which are largely beyond government control. For example, policy constraints have been introduced by the interaction of goods and services within software, and by the links between hardware and software industries and technologies, as described in chapters 3.1 and 7.

Likewise, as explained in chapters 5.4 and 6.3, the nature of development, production and replication of some technologies has been such that import liberalisation has represented the only viable policy option, while bureaucratic implementation difficulties have denied the possibility of differentiated software import liberalisation. On the other hand, the problems of foreign exchange availability have made certain other liberalisations unviable.

Arguments about whether or not liberalisation is objectively the most beneficial option therefore lose their importance when it is recognised that policy measures can only be enacted once they have passed through tests of technical, industrial, financial, bureaucratic and, above all, political feasibility. Uniform liberalisation and a close approach to the neo-liberal model are not viable policy options in the Indian context. The failure to achieve such uniformity and such a close approach even in one of India's most liberalised industries - software - amply illustrates this.

1.5. Overall conclusions about liberalisation and software industry development

In answering the originally posed question, this study suggests that policy liberalisation is only one of a number of factors affecting the Indian software industry's development, and that one cannot deduce any simple and positive relationship between liberalisation and industrial development.

Certain liberalisations have been a necessary, though not sufficient condition to produce some changes that include increases in quantitative industrial growth and efficiency, and some additional supply of scarce inputs. Import liberalisation has also been necessary given certain technological considerations, including the fact that no nation can be technologically-independent in all information technologies.

While liberalisations may have assisted some industrial 'growth', their impact on industrial 'development' is less positive. Certain liberalisations have brought a qualitative stagnation or regression that includes rising dependence on foreign firms, skills, market access and technology; loss of local technological capabilities and self-determination; future vulnerability; balance of payments problems; and a section of the local economy skewed to foreign needs.

Some liberalisations have also reinforced, or failed to alleviate, imbalances between export- and domestic-oriented production, between software services and software package production, and between large and small software firms. They have served to reinforce existing industrial structures, to increase external influences, and to increase the exposure of barriers and constraints which liberalisation itself cannot adequately address.

Therefore, simple and sweeping liberalisation - the broad recommendation from the neo-liberal model - cannot be seen as the solution to industrial development needs for four main reasons:

- because the effect of liberalisation can be described as assisting quantitative industrial growth but also the qualitative stagnation or regression of other industrial development;
- because factors other than state policy are largely responsible for many industrial developments;
- because government interventions have been a necessary part of industrial development in helping to create balanced and independent development, in overcoming barriers and input constraints, and as part of export orientation, encouragement of foreign investment and even as a complement to liberalisation;
- and because the constraints of the political economy and other factors make this type of liberalisation unfeasible.

That this is true even in a new, high technology, export-oriented, entrepreneurial and markedly liberalised industry like software is particularly significant.

2. Export orientation

Although associated to some degree with liberalisation, the Indian software industry's export orientation has been of separate interest because further conclusions can be drawn about the choices facing policy makers concerned with software industry development.

The impact of 'super export orientation'

As stated in chapter 3.1, the Indian software industry began by being wholly domestic-oriented and partly import-substituting. However, this did not last long and, during the majority of its existence and unlike most of Indian industry, the Indian software industry has been more greatly oriented to exports than to production for domestic consumption. In fact, as seen in chapter 4, it is an example of 'super export orientation' or export bias because exports bring more earnings, profits and other benefits than domestic market work.

Chapter 4.1.1 shows that, at root, it has been possible to export software because of the emergence of a global software market in the 1970s and because global production possibilities have been fuelled by a shortage of available skills and by job and technological standardisation. The Indian industry has been able to take a share of the export market thanks to its low labour costs and available skills (see chapter 4.1.2). That an export orientation has taken hold within the industry has been partly a result of government policy and partly because of differences between the export and domestic markets.

The result, detailed in chapter 4.2, is that export production has become a virtual enclave, with few of the links between export and domestic production that both could benefit from. Export bias has diverted inputs away from domestic-oriented production and helped to reinforce weaknesses and barriers within the domestic market which leads domestic-oriented work to produce less output, productivity and quality than exports, and to be unattractive to many producers. It has also helped production input constraints become more exposed because the Indian industry is denied the financial base, credibility, skills and products that could be provided if a mature domestic market had been allowed to develop.

Export bias has left the industry with little alternative but to embrace foreign collaborations. As already described in this chapter, one consequence of this has been rising economic and political power within the Indian economy for transnationals (albeit largely in alliance with sections of national capital) through their exploitation of the increasing importance of exports and investments. As a result, collaborations have fostered rising economic, political and technological dependence within India.

As noted in chapters 3 to 5, the export of services has brought a vulnerability to the industry because of the staff losses it encourages and because of a series of threats, which include changes to foreign visa regulations and other forms of protectionism; competition from other developing countries and from software packages; automation in the long term and rising skill requirements in the medium term; a diminution in the rate of 'contracting out'; alterations in collaborator strategies or economic well-being; and global recession and other macroeconomic change.

This export orientation has therefore been self-reinforcing because it encourages losses of staff overseas and a weak domestic market whic in turn, respectively discourages transfers of skills which could strengthen the domestic market and encourages further staff losses. The small size and revenue-earning capability of the domestic market also leads to poor quality work, which further reinforces its small size and revenue-earning capability.

Finally, this export orientation may also be politically self-reinforcing by encouraging external influences which can bring to bear relatively autonomous pressures on policy in favour of an expansion of exports or a weakening of indigenous competition.

Conclusions about export orientation

While India's 'super export orientation' in software has undoubtedly helped to bring a growth in industrial output and some access to capital, technology and skills, it has also brought technological and market access dependence, vulnerability of future growth, threats from automation, loss of self-determination, a weakened domestic market, and an *'enclave' industrialisation* with little value-added within India and with relatively few linkages or transfers to the domestic economy.

These findings certainly echo the shortcomings of super export orientation noted in chapter 1 related to balance of trade, macroeconomic factors, automation, and 'enclave' development. However, many of the outcomes described - growth, dependence, vulnerability and threats - would be likely to arise from any exports, not just from 'super' export orientation. This suggests that any orientation towards exports must be treated with great caution because of the economic and political self-reinforcement of this development path, and because of the potential harm to industrial development.

The findings point to the depth of understanding required before one can adequately assess the role of exports in industrial development. It is not sufficient merely to suggest export and domestic financial incentives be balanced because these two production directions are of different forms and have quite different impacts, which must be taken into account when considering the mix of export and domestic production to encourage.

In the case of the Indian software industry, exports should continue (and it would be politically impossible to stop them). However, it is also clear, particularly from chapters 3 and 4, that the imbalance between these two types of production is sufficiently great to be damaging to the industry's development. Redressing the balance through a greater integration of the two will require a reduction in pro-export biases.

Rather than just using fiscal incentives there is a need for government to focus on interventions which address the barriers and constraints that affect domestic-oriented production. This will involve minimising the costs and maximising the benefits of foreign collaborations, and strengthening local companies by encouraging local research and development, boosting the market for local production, substituting for multinational production inputs, and taking firm action on software piracy.

Just as production for software services suffers from an excess orientation to exports, so the findings of chapter 4 indicate that production for software packages (and hardware - see chapter 6.2.1) suffers from a deficient orientation to exports and a bias towards production for the domestic market. In this case, policy needs to ensure that there is compensation for the higher domestic incentives. However, this again will not be achieved solely through liberalisation and fiscal incentives. Intervention will also be needed to address some of the constraints on supply of production inputs and the barriers to export market entry, though some of the latter are likely to be beyond the ability of the government to tackle, which may force a degree of continued domestic orientation and of protection thanks to the lack of scale economies.

These findings support the general idea (which derives from the neo-liberal model) of a need to reduce the imbalance of incentives between domestic and export production; though this applies to situations of both export and domestic bias. However, the findings also show that bias and balance cannot be adequately analysed or addressed solely on a fiscal basis because some of the factors that make up the imbalance can only be addressed by non-fiscal government interventions. A full understanding of the causes and impacts of bias may also suggest the need for some continued degree of fiscal imbalance when, for example, external constraints render balance impossible.

3. General software policy-making issues

Although there are factors outside the control of government which help constrain both industrial development and the making of policy, governmental decisions about policy still have an important impact on industrial development. From this study, one can draw out a number of general factors that need to be considered when making policy.

Use of models

This study has provided ample evidence that software industry policy making should not be exclusively guided by one or other of the theoretical models described in chapter 1. In some ways, there has been support for the predictions of both models listed above. However, this also indicates the inadequacy of either individual model.

Being currently the more dominant of the two models, it is the neo-liberal which has received more attention within this study. This model has been seen to contain some useful elements, such as the recognition of potential imbalances between export and domestic production incentives, and the use of price mechanisms rather than direct controls in some circumstances. Its prescription - liberalisation - has been developmental to the extent that there have been some growth and efficiency and input supply and consumption benefits gained from some liberalisations in some circumstances.

However, the model has also been seen to be wholly inadequate to explain or prescribe for industrial development, having failed to deal satisfactorily with a number of findings which include:
- the way in which state and market have combined to shape this industry;
- the importance of entry barriers and input constraints;
- non-price factors and the multidimensional role of the state beyond purely economic matters;
- the necessity of intervention and its role within supposedly neo-liberal strategies, including export orientation, encouragement of foreign investment and, to some extent, import liberalisation;
- situations in which neo-liberal prescriptions are politically or financially unimplementable;
- the need for policy flexibility and specificity;
- many of the qualitative developments associated with liberalisations, such as loss of indigenous capabilities and control.

Nor has the structuralist model been seen to provide the 'answer'. Arguments about the inapplicability of sweeping prescriptions apply equally to this model, which has also failed to address adequately the developmental benefits that can arise from some liberalisations and some foreign investments in some circumstances; the developmental problems associated with some interventions and protection; and the technological necessity of some liberalisations.

The inadequacy of the continua described in chapter 1 can also be seen from the findings in this study. Although the continua are useful up to a point, they cannot encapsulate the changing nature of the relationship between state and industry. The continua must be dissociated because, as just noted, state intervention has played a role within export orientation, the encouragement of foreign investment and even import liberalisation. There is thus no simple relationship between foreign investment, outward-looking policies and liberalisation.

Nor are the individual continua an adequate representation of the situation described by the research findings. Liberalisation and intervention have co-existed and been complementary in the development of the Indian software industry. Similarly, for example, there can be no exclusive distinction between 'state' and 'market'. From chapter 4, it was seen that features of state policy and of the market - barriers, market size, skill availability - have acted together to shape the orientation and development of the Indian software industry. Similarly, from chapters 5 and 8, it was clear that, through its procurement policies and its ownership of production units, the state is also part of the market.

Overall, then, the individual theoretical models and related continua described in chapter 1 are not adequate to guide or describe software policy, and one must be wary of commentators who claim that certain national policies have been truly guided by one or other of these models.

Instead of the models, what is likely to be needed is a mixture of market liberalism and state intervention, and a mixture of import substitution and export promotion. Depending on the current state of national policy, there may be a need for some more interventions and/or some more liberalisations - the specific prescriptions will depend on various macroeconomic and specific national and industrial characteristics.

Specificity and co-ordination

Policy needs to be co-ordinated and planned in two ways. Firstly, there must be a co-ordination of different measures within a single sector. For example, there seems to have been some lack of clarity about the various export incentives described in chapter 4.2.3, and about the complementary inputs required when imports are liberalised, as detailed in chapter 5.1.

Secondly, there must be co-ordination between sectors, and this applies especially to co-ordination between the hardware and software sectors and between hardware and software policy. For example, it was the initial lack of such co-ordination that led to the unexpected rent-seeking and domestic leasing when import liberalisation relating to the software industry was combined with a situation of import protectionism in the hardware industry.

While policy must be co-ordinated, it will also need to be specific. The demands of political feasibility may require a compromise of particular industrial needs with economy-wide considerations, such as overall availability of foreign exchange but, nevertheless, the findings here support the view that sector-specific policies are possible, useful and necessary.

General, economy-wide export incentives were seen in chapter 4.2 to have proven unnecessary and therefore wasteful as far as software services exports are concerned because they failed to take account of the export bias already present. On the other hand, as detailed in chapter 8, government has been able to intervene most positively using very specific measures geared to particular industry requirements, and policy seems to have played a more positive role in the software industry's development since the government recognised software as a separate industry with specific needs.

The need for national specificity thanks to political and financial factors was noted in chapter 9, and the need for sectoral specificity has already been illustrated by the compulsions of particular technological, macroeconomic and bureaucratic constraints.

Timing and phasing

Policy prescriptions should also depend on the state of an industry's technological capabilities and competitiveness. As described in chapter 6.3, it is this which leads to quite widespread support in the literature for the timing and phasing of policies; it being advised that both domestic competition and import protection precede import liberalisation.

Within this study most of the relevant evidence has come from the hardware industry. For this, there appear to have been developmental benefits in spurring a certain level of domestic competition by liberalising industrial controls prior to liberalising import controls. It also seems clear that a period of import protection was useful prior to any import liberalisation in order to help build a local industrial base of capabilities.

What is less clear is the extent to which it is necessary and useful for import liberalisation to follow import protection and domestic competition - in the case of hardware, developmental benefits in the second half of the 1980s seem to have come more from government interventions and from continued protection than from import liberalisation. Therefore, while timing of policies is clearly important, one cannot recommend adherence to any set pattern of policy phasing. Choice of strategy will, for example, depend on the relative weight attached to production and consumption.

Responsiveness and stability

Chapter 8.3.5 describes the positive outcomes seen when Indian government policy was iterative and responsive in the case of training; focusing on different problems - overall numbers of graduates, curricula, supply of teachers and equipment, specific software industry needs - as and when they arose. There are other examples in chapter 8 relating to finance, telecommunications and purchasing, and in chapter 6.3 relating to hardware policy.

Responsiveness is also required because there can be unexpected outcomes to policy, as described in the case of hardware import and domestic leasing, and in the impact of export obligations on small companies. However, this needs to be balanced against the dangers of frequent changes in policy which, as noted in chapter 4, can discourage investment and encourage companies to adopt only short-term strategies. Thus, responsiveness must be combined, where possible given the political and other factors affecting policy, with a stability in the overall direction of policy.

Summary

As regards the software industry, it has been seen that, above all, there is a strong role for both government and policy in the process of industrial development. The state will perform best by adopting a contingent approach which mixes liberalisation and intervention, and domestic and export orientation, rather than slavishly following the prescriptions of either neo-liberalism or structuralism.

The state should use co-ordinated policies that complement each other and which have a stability of objectives but which are also skilfully, responsively and flexibly applied to specific industrial development needs. It must therefore continually monitor industrial and external circumstances, be selective in its policy choice, and mix some planning and some reaction to circumstances. The strengths of Indian software policy have come where it has followed this pattern and been non-dogmatic and responsive but also co-ordinated, detailed, specific and comprehensive.

4. Specific software policy-making issues

In the previous section, the implications of this study for the general form of software policy making were drawn out. However, one can also draw up recommendations about the specific content of software policy both for India and for other developing countries.

Indian software policy

Within the Indian example, two models for software industry growth were identifiable - the dominant one of export-led growth, and the other (mainly portrayed by CMC) of domestic market focus. From the findings it was not possible to say whether the latter would provide a better route to long-term industrial development but it was clear that a path of export-led, export-biased growth had many associated shortcomings.

Ideally, one would therefore recommend a much greater emphasis on the domestic market and a much reduced emphasis on exports. However, this is unrealistic in the Indian context for two main reasons. Firstly, because there has been so much investment and development with exports in mind - of institutional forms, collaborations, reputations, and of marketing, software development and bureaucratic capabilities. The retraining and other changes necessary to re-orient the industry would be very costly. Secondly, and more importantly, because the political economy that has developed around software and which governs policy is very much in favour of exports and would not permit such a change in focus (see, for example, Sridharan 1989).

Realistic policy recommendations for India can therefore only seek to build up the domestic market rather than to restrain exports, and to look for a balance between the two models rather than to instigate a bias against exports. As a result, the overriding recommendation for Indian software policy to emerge from this study is that the Indian software industry be developed in future by 'walking on two legs'; that is, by striving for greater balance and integration between production for exports and for the domestic market.

This will be achieved through government intervention and not through liberalisation. It will also be achieved by ensuring that domestic market production is not disadvantaged at the expense of biases to exports. This will involve an explicit recognition within policy of domestic-oriented production, and action to address domestic market constraints including an expansion of market size through government procurement and firm action on piracy; an encouragement of local R&D; substitution for other multinational inputs; and some continued protection for local software packages and services.

Reductions in bureaucratic procedure have been acceptable to India's overworked bureaucracy and have almost always been of benefit to the software industry. These should be encouraged to continue, for instance, by following the cash compensatory support example of issuing payment, or a licence, at the time of application and then checking it afterwards rather than making the company wait until all the paperwork is done.

Setting the level of import quotas and barriers has always been a balancing act between the interests of producers and consumers, and between the interests of various pressure groups. Hardware import barriers at the end of 1990 seemed to balance adequately the needs of consumers and producers, though circumstances may change these in the future, requiring Indian policy to continue to be flexible and responsive.

From a software industry development viewpoint and given software's specific technical characteristics, there seems little justification for the recent increase in software import duty from 60% to more than 100%. The increase seems unlikely to achieve much for the industry except to encourage more smuggling and piracy, which suggests that it should probably be reversed. Despite its 'natural' entry barriers for foreign firms, the domestic custom software market also needs to be protected because of its importance as a source for building local technological capabilities. Imported software services should therefore not be encouraged.

As regards other fiscal policy, the current level of cash compensatory support is more than adequate given the industry's export bias, and it should not be increased. Indeed, given that fiscal export incentives are largely unnecessary for software services, it should in fact be reduced for this type of production. The specific situation affecting this industry should also be addressed in the case of the 15% foreign exchange conservation tax, which could justifiably be removed for software companies since all their foreign exchange outgoings on marketing and travel are more than matched by subsequent earnings.

The findings of chapter 7 indicate the need for control over, and limitations to the activity of foreign multinationals. Present Indian government policy strikes a good balance between access and control, and no arguments have emerged from this study in favour of altering the present foreign equity rules to allow greater foreign control. By contrast, there have been a number of arguments against the presence of export processing zones and wholly foreign-owned, wholly export-oriented software companies. Though it is politically highly unlikely that these will ever be closed down, an expansion in numbers should not be encouraged.

There are more positive steps that can be taken to control foreign collaboration. One way in which Indian firms have avoided a number of the costs associated with foreign collaboration is by their own investment in foreign marketing and consultancy firms, and this should be explicitly legalised and procedurally encouraged. The government could also invite foreign consultants to run training courses in India, allowing a greater transfer of skills, particularly to domestic market production, than at present seen within most foreign collaborations.

In seeking to address biases against small firms, the Indian government could help by reducing the psychological barrier that export obligations on imported hardware present; by encouraging greater provision of finance and marketing assistance to such firms; and by ensuring that payments and allowances in policy are not all linked to, and dependent upon previous export earnings.

The final policy measures to be considered are those interventions described in chapter 8, which have proven to be an essential part of software industry development and which must continue. The government has been constantly revising many of its interventions and the suggestions that follow merely reinforce processes of change that are already underway.

Policy can help to overcome financial constraints by further expansion and encouragement of venture capital provision; by introducing grants for software development work; and through moves which encourage financial institutions to accept non-traditional forms of collateral. There needs to be a continuation of the current process of updating training curricula; of providing more teachers and more up-to-date equipment to training *institutions; and of increasing the number of software-related* courses, especially those on structured development methodologies, project management and analysis skills. Incentives for private software company training may also help to overcome the skill constraints within the Indian software industry.

While these measures may have some effect on domestic-oriented production, this could be more directly addressed by a greater spread of public sector software contracts and of public R&D funding to private companies, and by greater encouragement of industry-academia links. Local R&D incentives could also be targeted more successfully, perhaps on a results-based basis. The full implications of encouraging government agencies to purchase locally-produced software packages are unclear, but these agencies could certainly be made more aware that there are alternatives to imports and, as shown in chapters 4.2 and 6.1, that there will be industrial development benefits from local purchasing.

Despite the bias to exports, the industry's export efforts could be channelled more effectively by the provision of improved information on foreign markets and companies, for example, through the government's hiring of an international marketing consultant for market research and for export promotion. While the ExIm-administered marketing grant has clearly been very useful and should continue, more could also be done to orient exporters to regional markets and to other developing countries, following CMC's lead.

While an expansion of international communication links has helped to increase offshore working, extra attention may now need to be paid to the as-yet rather neglected area of local telecommunications. The software industry could also benefit from the creation of an organisation with a role like that originally suggested for the National Software Centre, which was intended to develop curricula, coordinate software research, assist companies with product benchmarking and documentation, undertake a technology watch, and provide a resource centre of foreign and local software, and a library of journals and other relevant information.

Software policy in other developing countries

This study has only focused on one country's industry, the development of which may have been dependent on certain nationally-specific factors.

Writers including Narasimhan (1984), Kaplinsky (1987:16), Schware (1987 and 1989) and Fialkowski (1990) identify a number of features common to most software industries in developing countries which have also been seen to be important within this study. These include low labour costs; the problems of local skill availability, especially higher-level skills; the small size of the domestic market; local productivity and quality problems; capital and marketing constraints; the distance from the main markets; a division of labour in exports; and the 'brain drain'.

On the other hand, there have been a number of important India-specific features identifiable within the present study. These include the potential for a large domestic market (albeit not greatly realised, at least for packages); a long history of software industry development and of government intervention; a large human resource base; and widespread use of English. It has also been made clear from chapter 9.3 that any policy recommendations will be bound by the specific nature of the state and of state-industry relations.

India was probably the first developing country to enter the global software market and was probably the largest developing country exporter in 1990. However, export-led growth cannot be the path followed by all developing countries because the market is not large enough (the 'fallacy of composition') and because export contracts tend to build on existing bases and relationships, making later entry increasingly hard.

Other developing countries will therefore be affected by even greater software export entry barriers than the Indian industry. Because of this and because of the costs associated with an export-led model of software development, it seems advisable that these other countries should avoid an export-led model and should focus much more on their domestic markets, at least initially, following the model implicit within CMC's performance (chapter 8.8) rather than the model represented by most of the Indian industry.

The findings presented here support the idea that software can be a good entry point into IT production for developing countries, thanks to the ability to find growing markets and relatively low entry barriers for certain types of software production. However, they also indicate the shortcomings of this approach, such as the great difficulty of entry into software package production (see chapter 6.1) and the dangers that automation will erode cost advantages, reduce the level of contracting out and, ultimately, remove the need for most current software development work (see chapter 5.3.3).

This study has pointed to the need for developing country governments to recognise the importance of barriers and input constraints that will affect the development of their software industries. Several of these barriers and constraints are described in chapters 4 and 8 but, in particular, governments must use policy to address the issues of human resource skills and technological capability, which are absolutely crucial to the *development of a software industry.*

Governments face a critical choice about what interventions to use in addressing barriers and constraints but this study has shown that, even in a situation of export orientation, they should not rely exclusively on foreign multinationals but must also act through direct and indirect state intervention. For a more domestic-oriented industry, there will be even less need for multinational involvement and there can therefore be greater reliance on state intervention.

The use of state intervention will have the further advantage of addressing the other potential imbalances that must be recognised within software industry development, between software services and software packages, small and large producers, and consumption and production. In all these cases, it will be not just policy but the creation of organisational structures that matters - permanent, central policy co-ordinating bodies and flexible, responsive policy implementation bodies.

Although technological considerations mean that developing countries will find it hard to avoid an undifferentiated policy of relative liberalism regarding software import, most specific prescriptions will be likely to mix both intervention and liberalisation, and will also depend on the particular industrial, financial, bureaucratic and political characteristics within individual nations. However, it is certain that government policy has a very important and necessary role to play in the development of software industries in developing countries.

5. Further research

The research reported here has set out a framework for understanding software policy and software industry development based on the development of a single developing country's software industry. One immediate possibility for further research would be a comparison of the Indian industry with those in other developing countries or in Eastern Europe. Such a comparison would bring greater confidence about the generalisability of conclusions but would also allow a greater understanding of the way in which different variables are associated with different developmental outcomes.

The most useful application of this would be to a comparison of India's export-led industrialisation model with a more domestic-oriented development model, such as that apparently presented by Brazil. This would allow a fuller consideration of the relative merits and demerits of these two models, and would improve the ability to make policy recommendations attuned to particular national and industrial circumstances.

Just as India's export bias in software suggests the need for a cross-country comparison so, too, does its comparatively early development of software policy and early entry into software production and software exports. A study of emerging industries and exporters in countries such as China, Hungary, Israel, the Philippines or the USSR would produce a greater understanding in general, but also an explanation of the additional constraints and opportunities for the majority of developing countries which, unlike India, are comparative late-comers to software in general and to software exports in particular.

Such a study might, for example, identify niche export markets that late-comers can exploit, or it might confirm the earlier suggestions that export orientation becomes increasingly disadvantageous as more developing countries enter the market. The study could also suggest competitive trends within the export market and the likely impact on Indian software exports.

While CMC has played an important role in India's software industry development, in China and Eastern Europe the public sector has been completely dominant. With the likelihood of an increased role for the private sector in these countries, it would be useful to study more closely the relationship and transfers between the public and private sectors in software industry development.

Similarly, the present study has pointed to many links, and the need for co-ordination between hardware and software industry development. Given that many developing countries will be attempting to develop software industries in the absence of an indigenous hardware production capability, it would be useful to understand more fully the extent to which software industry development depends on, and benefits from the hardware industry.

Both of these inter-sectoral comparisons could be drawn from cross-country studies and so, too, could the importance of English language skills as a variable in software industry development.

Finally, although this study drew substantial primary and secondary data as it was required from multinationals and from developed countries, the work was essentially done from an Indian perspective. Given the global nature of the software industry and the importance of global trends in determining national industrial development, it would be helpful to do some further research from a developed country perspective.

This would explain more than is currently understood about the actions, strategies and underlying motivations within software-related multinationals, which would assist policy making and would make clearer the extent to which external pressures influence and constrain policy making in India.

Such a study would also turn round the focus of chapter 7 and seek to understand the global importance of India as a software source and the extent to which foreign firms and countries are dependent on, and benefit from Indian technology and skills.

APPENDIX A
ADDITIONAL DATA

This appendix provides additional data on the organisations surveyed, currency conversion rates used, and foreign collaborations. It also includes a glossary.

1. Organisations surveyed

The list below indicates the name, commonly-used abbreviation and head office location of all the organisations in which staff members were interviewed between 1988 and 1990.

Top ten software exporters of 1988

Tata Consultancy Services (TCS); Bombay
Tata Unisys Ltd (TUL); Bombay
Citicorp Overseas Software Ltd (COSL); Bombay
Datamatics Consultants Ltd (Datamatics); Bombay
Texas Instruments (India) Pvt Ltd (TI); Bangalore
Infosys Consultants (Infosys); Bangalore
Hinditron; Bombay
Patni Computer Systems (PCS); Bombay
International Computers Indian *Manufacture (ICIM); Bombay*
Kirloskar Computer Services (KCS); Bangalore

Other major exporters

Bakst Indika Consultancy (Bakst); New Delhi
Blue Star; Bombay
CMC Ltd (CMC); New Delhi
Computronics (India) Ltd (Computronics); New Delhi
Data Capture Services; Bombay
Data Consultancy Services (DCS); Bombay
Data Software Research Company (DSRC); Madras
Data Systems Services (DSS); Pune
Delhi Cloth Mills Data Products (DCM DP); New Delhi
Future Software (Future); Madras
Indusa Information Technology (Indusa); Bombay
International Software India Ltd (ISIL); Madras
National Institute of Information Technology (NIIT); New Delhi
Rolta Computer and Industries (Rolta); Bombay
Thermax; Pune
Wipro Information Technology Ltd (WITL); Bangalore
Wipro Systems Ltd (WSL); Bangalore

Smaller exporters

Access Information Systems (AIS); Bombay
Datapro; Bombay
Indotronix Computers (Indotronix); Hyderabad/Secunderabad
Intime Consultants (Intime); Bombay
Kale Consultants (Kale); Bombay
Maegabyte Consultancy Services (Maegabyte); Bombay
Management and Software Technology (Mastek); Bombay

Sonata; Bangalore
Systime Computer Systems (Systime); Bombay
TSG Consultants (TSG); New Delhi

Domestic-oriented software producers

Bhari Information Technology Systems (Bitech); Madras
Computer Aided Learning Systems (CALS); New Delhi
Comstruct Software (Comstruct); Bombay
Era Electronics (India) Pvt Ltd (Era); Hyderabad/Secunderabad
Kasbah Systems Software (Kasbah); Madras
Murugappa Electronics (Murugappa); Madras
Radix Computer Services (Radix); New Delhi
Sarag Systems (Sarag); Hyderabad/Secunderabad
Satyam Computer Services (Satyam); Hyderabad/Secunderabad
Softek; New Delhi
Software Research Group (SRG); Bangalore
Tata Engineering and Locomotive Company (Telco); Pune
Tej Computers (Tej); Bombay

Hardware and component manufacturers

Delhi Cloth Mills Data Products (DCM DP); New Delhi
Electronics Corporation of India Ltd (ECIL); Hyderabad/Secunderabad
Hindustan Computers Ltd (HCL); New Delhi
Operations Research Group Systems (ORG); Baroda
Precision Electronic Components (PEC); Hyderabad/Secunderabad

Public sector computer systems users

Indira Gandhi National Open University (IGNOU); New Delhi
Ministry of Finance (MoF); New Delhi
Ministry of Railways (MoR); New Delhi
National Informatics Centre (NIC); New Delhi
Steel Authority of India Ltd (SAIL); New Delhi

Policy-making government organisations

Department of Electronics (DoE); New Delhi
Directorate General of Trade and Development (DGTD); New Delhi
Ministry of Commerce (MoC); New Delhi
Ministry of Finance (MoF); New Delhi
Ministry of Science and Technology (MoST); New Delhi

Policy-implementing government organisations

Customs; various
Electronics and Computer Software Export Promotion Council (ESC); New Delhi
Export-Import Bank (Exlm Bank); Bombay
Industrial Development Bank of India (IDBI); Bombay
Industrial Credit and Investment Corporation of India (ICICI); New Delhi
National Centre for Software Technology (NCST); Bombay
Office of the (Joint) Chief Controller of Imports and Exports ((J)CCIE); various
Reserve Bank of India (RBI); Bombay
Santa Cruz Electronics Export Processing Zone Administration (Seepz administration); Bombay
State Bank of India (SBI); Bombay
Trade Development Authority (TDA); New Delhi
Videsh Sanchar Nigam Ltd (VSNL); Bombay

Industrial associations

Confederation of Engineering Industry (CEI); New Delhi
Manufacturers Association for Information Technology (MAIT); New Delhi
National Association of Software and Service Companies (Nasscom); Bombay

Academic institutions

Asian Institute of Informatics (AII); Madras
Central Labour Institute (CLI); Bombay
Centre for Development Studies (CDS); Trivandrum
Indian Institute of Technology (IIT-D); New Delhi
Institute for Social and Economic Change (ISEC); Bangalore
Jawaharlal Nehru University (JNU); New Delhi
National Council of Applied Economic Research (NCAER); New Delhi
National Institute of Science, Technology and Development Studies (NISTADS); New Delhi
Tata Institute of Fundamental Research (TIFR); Bombay

Computing journals

Computers Today; New Delhi
Computing; London
Dataquest; New Delhi
PC World; New Delhi

UK-based software companies and related organisations

Broadgate Systems Ltd; London
Computers Services Association (CSA); London
Digital Equipment Company (DEC); London
Ilacs Software; London
International Computers Ltd (ICL); London
Logica; London
National Computing Centre (NCC); Manchester
Systems Designers; London
Third Wave Systems; London

Miscellaneous

British High Commission; New Delhi
International Data Corporation (India) Ltd (IDC); New Delhi
United States Embassy; New Delhi

2. Currency conversion rates

Convertor rates used for US$1:
1980 - Rs.7.75; 1980/1 - Rs.7.9; 1981 - Rs.8.7; 1981/2 - Rs.9.0;
1982 - Rs.9.5; 1982/3 - Rs.9.7; 1983 - Rs.10.2; 1983/4 - Rs.10.34;
1984 - Rs.11.5; 1984/5 - Rs.11.9; 1985 - Rs.12.15; 1985/6 - Rs.12.2;
1986 - Rs.12.6; 1986/7 - Rs.12.8; 1987 - Rs.12.9; 1987/8 - Rs.13.0;
1988 - Rs.14; 1988/9 - Rs.14.5; 1989 - Rs.16; 1989/90 - Rs.16.8;
1990 - Rs.17.5.

Convertors for Rs. to US$ devaluation:

80/1 - 1/2	-13.9%
1/2 - 2/3	-7.8%
2/3 - 3/4	-6.6%
3/4 - 4/5	-15.1%
4/5 - 5/6	-2.5%
5/6 - 6/7	-4.9%
6/7 - 7/8	-1.6%
7/8 - 8/9	-11.5%
8/9 - 89/90	-15.9%

3. Foreign collaborations

Listed below are the foreign collaborations relating to information technology known to have been active in India up to 1990. The foreign company is listed first, followed by the name of the Indian collaborator, partner or subsidiary. The type of collaboration and type of technology involved are shown in brackets, followed by the year of start of collaboration, if known. The equity investment of the foreign company is shown where applicable. All the foreign companies are based in the USA unless shown otherwise.

Computer collaborations

Acorn (UK) - SCL (Technical; micros) post-1984, pre-1987
Alpha Micro Systems - UMCL (Technical; supermicros) post-1984, pre-1987
American Megatrends - AMI-Sanag (Agency; supermicros) 1989
Apple - Raba Contel (Agency; micros) 1985
AT&T - Datamatics (Agency; computers) 1985
Bull International (France) - PSI Data Systems (Joint venture (21% raised to 40% in 1990); mainframes) 1987
Burroughs - TCS (Agency; computers) 1973/4-1977
Charles River Data Systems - Sunray Computers (Unstated; supermicros) 1983
Commodore International - Commander Computers (Technical; PCs and peripherals) 1987
Control Data Corporation - ECIL (Technical; mainframes) 1986
Convergent Technologies - Uptron (Technical; supermicros) 1987
Convex - WITL (Agency; minisupercomputers) 1989
Dansk Data (Denmark) - ORG Systems (Technical; supermicros) 1986
Data General - PCS (Agency; minis) 1977
Data General - PCS (Joint venture (40%); minis) 1982 (or 1987)
DEC - Hinditron (Agency; computers) 1980
DEC - Hinditron (Joint venture (40%); minis) 1988
Elxsi Systems - Tata-Elxsi (Technical; mainframes) 1989
Harris Computer Systems - ESPL (Technical; superminis) 1987
Hewlett-Packard - Blue Star (Agency; minis) 1984
Hewlett-Packard - Blue Star (Joint venture (40%); computers) 1989
Honeywell Bull - Nelco (Technical; supermicros) 1986
ICL (UK) - ICIM (Joint venture (40%); mainframes and minis) 1976 (subsidiary from 1963)
Ironics - Prompt Computer Services (Technical assistance; supermicros) 1987
Labtam Info (Australia) - Datalab (Technical; workstations) 1989
MAI Basic Four - Rolta (Agency; superminis) 1986
MIDS Quentel - Nelco (Technical; minis) post-1984, pre-1987
Mitac (Taiwan) - Bush India (Technical; PCs) 1987
Nixdorf (Germany) - Kale (Agency; hardware and software systems) 1986
Norsk Data (Norway) - ECIL (Technical; superminis) 1985
Norsk Data (Norway) - Indchem (Joint venture (unknown %); minis) 1986
Olivetti (Italy) - Modi (Joint venture (40%); micros) 1987
Parallel Computers - WITL (Technical; minis) 1987
Philips (Holland) - Philips India (Joint venture (unknown %); micros and peripherals) 1989
Prime - IDM (Technical; superminis) 1986
Silicon Graphics - OMC (Technical; workstations) 1988
Solborne Computer - Interface (Technical; workstations) 1989
Sperry - ORG (Agency; computers) 1970s (defunct after 1986)
Tadpole Technologies (UK) - Minicomp (Technical; supermicros) 1987
Tandem - WITL (Agency; OLTP computers) 1989
Tandy Corporation - DCM DP (Technical; micros) 1981
Texas Instruments - Zenith Electronics (Agency; computers) pre-1987
Tolerant Systems - HCL (Unknown; minis) 1987
Triad Micro - Infotech (Technical; supermicro) 1987

Unisys - TUL (Joint venture (50% in 1977, diluted to 40% in 1978); mainframes and minis) 1977 (former relationship as Burroughs-Tata Burroughs Ltd until 1986)
Wang Laboratories - Digitron Computers/Datamatics (Agency; minis) pre-1980
Zenith Data Systems - IDS (Agency; micros)

Specialist computer collaborations

Apollo - HCL (Technical; CAD/CAM workstations) 1985
British Telecom (UK) - India Telecomp (Unstated; computer-based communications *systems) 1987*
Computervision - TUL (Unstated; CAD/CAM systems) 1986
GE Medical Systems - WITL (Technical; diagnostic and imaging systems) 1989
Intergraph - Rolta (Agency; CAD/CAM) 1986
Micro Control Systems - Ashtech Systems and Services (Agency and exports to parent; CAD/CAM systems) 1985
Motorola - Blue Star (Technical; datacoms products) 1989
Schiffo (Germany) - IDM (Technical; CAD/CAM systems) 1989
SID Informatics (Brazil) - DCM DP (Technical; banking systems) 1989
Solustan Inc - ATE (Unstated; computer - based publishing and typesetting) 1987
Sun Micro Systems - WITL (Technical; CAD/CAM workstations) 1987
Sun Micro Systems - PCL (Agency; CAD/CAM workstations) 1989

Peripherals and related collaborations

C-ITOH (Japan) - Essen Peripherals (Technical; printers) 1986
Centronics - ICIM (Technical; printers) 1986
Citizen (Japan) - TVS Electronics (Technical; printers)
Data Products Corp - Lipi Data Systems (Technical; printers) 1984
EIEN Enterprise (Japan) - Priya Electronics and Chemicals (Agency; printers)
Elcon (Canada) - Zenith (Technical; communications products) 1989
Epson (Japan) - WITL (Technical; printers) 1986
Honeywell Bull (Italy) - Larsen & Toubro (Technical; printers)
Houston Instruments - Digital Electronics (Technical; plotters) 1981
Intel Corporation - Advanced Micronic Devices (Agency; processors & boards)
Keytronics - Compkeys (Technical; keyboards)
Miniscribe - Priya Electronics and Chemicals (Agency; disk drives)
Mitsubishi Electric Corporation (Japan) - Digital Instruments & Controls (Technical; monitors) 1984
Multitech Systems - Multitech Computers (Affiliate; modems) 1986
NEC (Japan) - Bush India (Technical; monitors) 1987
Newbury Data Recording (UK) - Priya Electronics and Chemicals (Agency; printers and *monitors and disk drives)*
North Atlantic Industries - Godrej & Boyce (Unstated; printers) 1985
Novell - Zenith Computers (Agency; LANs) 1987
Oak Industries - O/E/N (Unstated; keyboards and components) 1986
Output Technology Corp - Transmatic Systems (Unstated; printers)
Remex - O/E/N (Technical; disk drives)
Samsung (South Korea) - Essen Peripherals (Technical; monitors) 1986
Star Micronics (Japan) - Aptek Computers (Technical; printers) 1987
Sysmode (France) - Online (Technical; modems) 1987
Tall Grass Technologies - TVS Electronics (Technical; tape streamers)
Tandon - Tandon (Affiliate; disk drives)
TEAC Corp (Japan) - Priya Electronics and Chemicals (Agency; disk and tape drives)
TEAC - Sujata Electronics (Unstated; disk drives)
Thomson (France) - Gebbs Data Products (Unstated; monitors) 1987
Tiara Micro - TVSE (Technical; LAN cards) 1989
Western Digital - Priya Electronics and Chemicals (Agency; controller cards)
Xylogics - Priya Electronics and Chemicals (Agency; controller cards)
Y E Data (Japan) - Larsen & Toubro (Technical; disk drives)

Software distribution agreements

Accugraph Corp (Canada) - Mastek (Agency; software) 1987
Artecon Inc - Eiko (Agency; software) 1988
Ashton-Tate - Wipro Systems Ltd (Agency; software) 1988
Borland International - Infosys (Agency; software) 1987
Cullinet - PCS (Agency; software) 1988
Fox Software - Sonata (Agency; software) 1990
Hochitief & Rotring (Germany) - PCL (Agency; CAD software) 1989
IBM - ORG (Systems integration) 1989
Information Builders - NIIT (Agency; software) 1988
Informix Software - Indotronix (Agency; software tools) 1987
Informix Software - IDM (Agency; software tools) 1990
Ingres Corp - Mastek (Agency; software tools) 1988
Ingres Corp - Pertech Computers Ltd (Agency; software tools) 1990
Intec - Indotronix (Agency; software)
Interactive CAD Systems - Indotronix (Unstated; software) 1987
James Martin Associates - Intecos (Agency; software) 1989
Lotus Development Corp - Computer Point (Agency; software) 1986
Lotus Development Corp - TCS (Agency; software) 1989
McDonnell Douglas Information Systems - TCS (Agency; software) 1988
Microfocus - Vishesh Technology (Agency; software compilers) 1987
Microsoft - TUL (Agency; software) 1987
Microtecture - Indotronix (Unstated; software) 1987
Nantucket - Peutronics (Agency; software) 1987
Oracle Corp - TCS (Agency; software) 1987
P-Stat Inc - Indotronix (Unstated; software) 1987
Paperback Software - NIIT (Agency; software)
Peter Norton Computing - Infosys (Agency; software tools) 1990
Santa Cruz Operation - Coromandel Software (Agency; software)
Santa Cruz Operation - Tata Unisys Ltd (Agency; software) 1989
Serbi (France) - Unicorp Computers (Agency; CAD software) 1989
Software Link - MCS (Agency; LAN software)
Unify Corp - Godrej & Boyce (Agency; software)
Unify Corp - ITC (Agency; software) 1990
WordPerfect Corp - Pertech Computers Ltd (Agency; software) 1989

Software export collaborations

AT&T - Datamatics (Contractor; software export) 1987
ANZ International (Australia) - Index Computing (Indian subsidiary (100%); software export) 1990
Bakst International - Bakst Indika (Joint venture (40%); software export) 1987
British Telecom (UK) - Mahindra British Telecom (Joint venture (40%); software export) 1989
Burroughs - TCS (Contractor; software export) 1973/4-1977/8
Citicorp - COSL (Indian subsidiary (100%); software export) 1985
Data General - PCS (Contractor; software export) 1977
DEC - Hinditron (Contractor; software export) 1980
DEC - DEIL (Joint venture (40%); software export) 1988
DPS-Europe (Holland) - DPS (Overseas equity (unknown %); software export) 1990
DSS-Bharain - DSS (Overseas equity (49%); software export) 1981
G4S-Olivetti (Italy) - Modi Rubber (Unstated; software export) 1987
Hewlett-Packard - Blue Star (Contractor; software export) 1984
Hewlett-Packard - HP (India) Software (Indian subsidiary (100%); software export) 1989
ICL (UK) - ICIM (Joint venture (40%); software export) 1976 (subsidiary from 1963)
Indotronix International - Indotronix (Joint venture (70%); software production) 1987
Indusa (US) - Indusa (Overseas equity (50%); software export) 1988
Instaplan Corp - Wipro Systems Ltd (Marketing arm; software product export) 1986

Kurt Salamon Associates - Infosys (Overseas equity (40%); software export) 1988
Matra (France) - Usha Rectifier (IC design centre) 1989
Nixdorf (Germany) - Kale (Contractor; software export) 1989
Tandem - TCS (Contractor; software export)
Texas Instruments - Texas Instruments (India) Ltd (Indian subsidiary (100%); software export) 1986
Uberoi International - Princeton Software (Joint venture (unknown %); software export)
Unisys - Tata Unisys Ltd (Joint venture (50% in 1977, diluted to 40% in 1978); software production) 1977 (former relationship as Burroughs-Tata Burroughs Ltd until 1986)
Vault Corp - Systems Data Controls (Joint venture (unknown %); software export) 1988
Verifone - Verifone Software (Indian subsidiary (100%); software export) 1990
Wang Laboratories - Datamatics (Contractor; software export) pre-1980
Westinghouse/Indus Technology - WTI Advanced Technology Ltd (Joint venture (40%); software export) 1990

4. Glossary of acronyms

1 crore (cr) = 10 million
1 lakh (l) = 100,000

301 - section number of 1974 US Trade Act
3GL - third generation programming language: one of the most common programming languages such as COBOL, BASIC or C
4004, 8008, 8080, 8085, 8086, 8088, 80186, 80286, i386, i486 - types of central processing unit manufactured by US company Intel
4GL - fourth generation programming language: a modern, powerful programming language used to create software
68000, 68020 - types of central processing unit manufactured by US company Motorola
AS400 - model number of IBM minicomputer
Assocham - Association of Chambers of Commerce: trade association for Indian companies
BASIC - commonly-used third generation programming language
BM - pseudonym used by contributor to Economic and Political Weekly
BSc - Bachelor of Science
BTech - Bachelor of Technology: undergraduate technology-related degree
C - commonly-used third generation programming language
C&C - Computers and Communication: Indian computer journal
case - computer-aided software engineering: highly-automated method for producing software
CCS - cash compensatory support: subsidy paid to exporters
CeBIT - annual information technology trade fair in Germany
CEI - Confederation of Engineering Industry: trade association for Indian technological companies
CMC - formerly Computer Maintenance Corporation: Indian public sector software and computer services company
COBOL - commonly-used third generation programming language
Congress (I) - Congress (Indira): major Indian political party
COSL - Citicorp Overseas Software Ltd: Indian software export company and wholly foreign-owned subsidiary of US banking corporation
CP/M - Control Program for Microprocessors: common operating system for microcomputers that predates MS-DOS
CSI - Computer Society of India: Indian association for computer professionals and academics
dBase - leading database for microcomputers, produced by Ashton-Tate
DCA - Diploma in Computer Applications: computing-related qualification
DCE - Diploma in Computer Education: computing-related teaching qualification
DCL - Datamatics Consultants Ltd: leading Indian software company
DCM DP - formerly Delhi Cloth Mills Data Processing group: leading Indian hardware and software company
DEC - Digital Equipment Corporation: large US-based computing transnational
DEIL - Digital Equipment (India) Ltd: Indian hardware and software company, part-owned by US firm DEC
DGTD - Directorate General of Trade and Development: Indian government body dealing with regulation and promotion of overseas trade
DoE - Department of Electronics: Indian government department which oversees policy formation and implementation in all branches of electronics
DoT - Department of Telecommunications: Indian government department which oversees telecommunications policy formation and implementation
DP - data processing: outmoded term used for computer-related activities in commercial and other organisations
DTA - domestic tariff area: geographical area of production within India excluding that of export processing zones
ECIL - Electronics Corporation of India Ltd: Indian public sector hardware manufacturer
EEPC - Engineering Export Promotion Council: Indian joint government-industry body which held responsibility for electronics and software export promotion until 1987

EI&P - Electronics - Information & Planning: journal of the Department of Electronics
EIU - Economist Information Unit: UK market research organisation
EOI - export-oriented industrialisation: strategy for industrialising by encouraging local industry to compete internationally
EOU - export-oriented unit: production unit from which all output is exported
EPW - Economic and Political Weekly: leading Indian journal
EPZ - export processing zone: designated area within a country, separate from domestic tariff area, in which specific export-oriented regulations apply
ESC - Electronics and Software Export Promotion Council: Indian joint government-industry body intended to promote exports and liaise between government and industry on policy
ET&T - formerly the Electronics Trade and Technology Development Corporation: Indian public sector body trading in and producing electronics-related goods
ExIm Bank - Export-Import Bank: Indian government-owned body which finances exports and imports
FERA - Foreign Exchange Regulation Act: regulates movement of foreign exchange and investment of foreign companies in India
FICCI - Federation of Indian Chambers of Commerce and Industry: trade association for Indian companies
GATT - General Agreement on Tariffs and Trade: international negotiating forum seeking to establish framework and ground rules for international trade
GoI - Government of India
HCL - Hindustan Computers Ltd: large Indian hardware manufacturer
i386, i486 - see 4004
IBM - International Business Machines: largest US-based computing transnational
IBM 370 - large IBM computer of 1970s vintage
ICICI - Industrial Credit and Investment Corporation of India: partly state-owned body which finances industrial development
ICIM - International Computers Indian Manufacture: large Indian hardware and software producer, part-owned by UK firm ICL
ICL - International Computers Ltd: large UK-based computing transnational
IDC - International Data Corporation: US and Indian market research organisation
IIS - Indian software export company
IMC - Information Management Consultants: US software company
IPRs - intellectual property rights: legal rights covering intangible goods
IPSS - International Packet Switching Service: global digital communications network
ISG - pseudonym used by contributor to Economic and Political Weekly
ISI - import-substituting industrialisation: strategy for industrialising by protecting local industry from imports and encouraging industry to produce local versions of foreign goods
IT - information technology: a group of information- and electronics-based technologies including computers and computer software
Lok Sabha - lower house of Indian parliament
Mahindra-BT - Indian software company part-owned by UK company British Telecom
MAIT - Manufacturers' Association for Information Technology: main trade association for Indian hardware companies, also has software sub-committee
MCA - Master of Computer Applications: computing-related qualification
MNC - multinational corporation: technically a company operating in more than one country, but typically associated with very large companies with worldwide operations
MoC - Ministry of Commerce: Indian government ministry dealing with trade
MoF - Ministry of Finance: Indian government ministry dealing with fiscal policy
MRTP - Monopolies and Restrictive Trade Practices act: regulates the activities of very large companies in India
MS-DOS - Microsoft disk operating system: very common operating system used on all IBM-compatible personal computers
MTech - Master of Technology: postgraduate computing-related degree
MTNL - Mahanagar Telephone Nigam Ltd: state-owned body dealing with installation of urban telecommunications in India
Nasscom - National Association of Software and Service Companies: main trade association for Indian software companies

NCST - National Centre for Software Technology: government body set up to develop software and software production technologies within India
NIC - National Informatics Centre: government body co-ordinating computerisation of Indian government departments
NICs - Newly-Industrialising Countries: those developing countries which have experienced strong industrial growth over the past 20-30 years; often synonymous with the four 'Asian tigers' - Singapore, Hong Kong, Taiwan, South Korea - but may also include countries such as Brazil, Mexico and India
NRI - non-resident Indian: someone born in India, but now resident overseas
NSC - National Software Centre: government body set up to act as a resource centre for the Indian software industry
NZ - New Zealand
OGL - Open General Licence: Indian equivalent of delicensed imports
ORG - Operations Research Group: Indian hardware and software company
PC - personal computer: generally synonymous with microcomputer
PCS - Patni Computer Systems: Indian hardware and software company
PDP 11/44 - DEC-produced minicomputer of 1970s vintage
PM - Prime Minister
PSI - Indian hardware and software company
PSS - Packet Switching Service: digital communications network
R&D - research and development
RBI - Reserve Bank of India: Indian government organisation that oversees currency regulations and transactions
RFE - reverse functional engineering: manufacture of a copy of something through mimicry of its functions rather than its content
RISC - Reduced Instruction Set Chip: fast-performing central processing unit
Rs. - rupees: Indian currency
SDA - Software Development Agency: sub-department within the Department of Electronics responsible for co-ordination of Indian software policy and software industry activities
Seepz - Santa Cruz Electronics Export Processing Zone: leading Indian free trade zone for export of electronics goods, including software; located in Greater Bombay
T&M - time and materials: method of charging export contracts on a regularly-billed basis when only staff, rather than software, are exported
TBL - Tata Burroughs Ltd: former name of TUL
TCS - Tata Consultancy Services: principal Indian software company
TDA - Trade Development Authority: Indian government body with responsibility for promoting foreign trade
TDICI - Technical Development and Investment Corporation of India: ICICI subsidiary with responsibility for venture capital disbursements in India
TI - Texas Instruments (India) Ltd: Indian software export company and wholly foreign-owned subsidiary of US hardware corporation
TI&M - Tube Investments and Murugappa: software company belonging to large Indian business group
TNC - transnational corporation: see MNC
TSG - Indian software company
TUL - Tata Unisys Ltd: principal Indian software company
UK - United Kingdom
UNIDO - United Nations Industrial Development Organisation: international body with responsibilities for industrial development
Unix - leading operating system used on microcomputers and minicomputers
US/USA - United States of America
US$ - US dollar: US currency
USSR - Union of Soviet Socialist Republics
VSNL - Videsh Sanchar Nigam Ltd: state-owned body dealing with installation of international telecommunications links from India
WITL - Wipro Information Technology Ltd: Indian hardware and software company
WSL - Wipro Systems Ltd: Indian software company

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